

THE PEOPLE OF THE STATE OF NEW YORK,
COMPLAINANTS,

VS.

STATE OF NEW JERSEY ET AL.

COMPLAINANTS' EXHIBIT No. 140.

Showing Condition of Water at Harrisburg, Pa., in 1903.

JAMES D. MAHER,
Commissioner.

Board of Public Works, Harrisburg, Pa. Color of Turbidity of Susquehanna River under center of spans of Walnut Street Bridge, Harrisburg, Pa, on certain days in 1903.

Table No. ^{ing} - show Colors of Turbidities of Samples - mathematically expressed.

(The figures represent percent which each color has in compound or fused color by color-top method)

Sample Number	Station on River	Gauge Height	Sediment							Turbidity							Red							Yellow							White							Black						
			Mar. 1	Mar. 3	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Apr. 16	Mar. 1	Mar. 3	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Apr. 16	Mar. 1	Mar. 3	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Apr. 16	Mar. 1	Mar. 3	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Apr. 16	Mar. 1	Mar. 3	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Apr. 16	Mar. 1	Mar. 3	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Apr. 16
	No. 1 1/2	13.4	thin	can	can	can	can	can	1000	850	550	150	800	250	170	5	32.5	3	145	22	125	6	5	23	3	8	22	17	45	2	10	0	6	12	6.5	35	88	245	94	71.5	43	64	86	
	No. 1	13.4	thin	can	can	can	can	can	1200	950	500	500	800	250	170	6.5	33	6	145	22	125	6.5	5.5	23	3	8	23	17	45	1.5	8.5	0	6	18.5	6.5	5	86.5	355	91	71.5	41.5	64	82.16	
	No. 1 1/2	13.4	thin	can	can	can	can	can																																				
	No. 2	13.4	thin	can	can	can	can	can	1600	1000	450	450	1000	280	150	8	32.5	2	22	30	19	10.5	6.5	23	23	12	23	14	8	4	10	0	8	10	7	8.5	81.5	345	95.5	58	27	55	73	
	No. 3	13.4	thin	can	can	can	can	can	1700	1100	180	450	1500	280	140	16.5	32.5	5	28.5	31	19	14.5	11.5	20	4.5	12.5	24	24	13.5	3	0	3	7.5	12	8	9.5	69	37.5	87.5	56.5	33	44	6.5	
	No. 4	13.4	thin	can	can	can	can	can	1800	1100	170	450	1400	270	140	30	32	10	27	31	18.5	19	15	23	15	14.5	24	24	15	3.5	9	9	9	12	9.5	13	56.5	36	66	49.5	33	48	53	
	No. 5	13.4	thin	can	can	can	can	can	1800	900	110	450	1300	260	160	33	34.5	13	30	31	22.5	19	16	20.5	18	17.5	24	22.5	15	5.5	8	10.5	8	12	9	13	45.5	37	58.5	44.5	33	46	53	
	No. 6	13.4	thin	can	can	can	can	can	500	850	110	450	1300	250	160	33	30.5	13	83	31	24	20	18.5	24	18.5	18.5	24	24.5	17	7	9	12	8	12	10.5	14	41.5	36.5	56.5	40.5	33	41	49	
	No. 7	13.4	thin	can	can	can	can	can	1200	750	110	100	1200	280	190	42	30.5	13	34.5	30	22.5	20	18.5	24	18.5	20	23.5	20	17	4.5	9	12	8	12	8.5	14	35	86.5	58.5	37.5	34.5	46	49	
	No. 8	13.4	thin	can	can	can	can	can	1000	660	90	400	1100	200	200	42	30.5	13	24.5	30	20	23.5	18.5	24	18.5	20	23.5	24	16	7	9	12	8	11	11	10	32.5	36.5	56.5	37.5	25.5	45	50.5	
	No. 9	13.4	thin	can	can	can	can	can	900	600	140	400	900	170	220	42	29.5	13	34.5	30	18.5	23.5	20.5	23	18.5	20	23.5	26	16	5	10.5	10	8	11.5	12	10	32.5	57	58.5	37.5	35.0	43.5	50.5	
	No. 10	13.4	thin	can	can	can	can	can	800	500	170	350	750	130	250	41	29.5	17.5	36.5	30	20	29.5	23.5	23	19	21	4.5	27	16.5	7.5	10.5	10	8	11.5	10	9.5	28	37	43.5	34.5	35	40	44.5	
	No. 11	13.4	thin	can	can	can	can	can	900	450	230	300	550	110	300	36.5	29.5	35.5	4.5	30	19.5	32	24	23	20	22	33.5	28	16.5	9	10.5	10	8	11.5	12	9.5	30.5	37	34	29.5	25	40.5	42	
	No. 12	13.4	thin	can	can	can	can	can	1000	400	260	350	350	85	350	36.5	29.5	34	48.5	48.5	32	24	23	20.5	22	24		16.5	8	10.5	10	8	10		9.5	31.5	37	35.5	24.5	21.5	42			
	No. 13	13.4	thin	can	can	can	can	can	1100	400	280	400	500	110	350	37	29.5	32.5	41	41.5	19	32	24	23	20.5	21.5	28	27.5	16.5	7.5	10.5	10	8	12.5	11	31.5	27	37	29.5	18	40.5	40.5		
	No. 14	13.4	thin	can	can	can	can	can	1300	400	290	500	500	120	400	34.5	29.5	31.5	39.5	41.5	19	32	24	24	21.5	22	27.5	27.5	11.5	8	9	10.5	9	11.5	12.5	11	33.5	36.5	36.5	29.5	19.5	41	40.5	
	No. 15	13.4	thin	can	can	can	can	can	1800	350	350	500	550	120	400	31	29.5	31.5	37.5	43	15	32	24	23	21.5	22	26	25	19.5	8	10.5	10.5	9	11	13.5	11	32	37	36.5	31.5	20	44.5	37.5	

Gauge Height

13.4 14.5 9.4 15.2 14.2 11.0 12.7

Compliments Exhibit No. 140
James D. Maher

THE PEOPLE OF THE STATE OF NEW YORK,
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STATE OF NEW JERSEY ET AL.

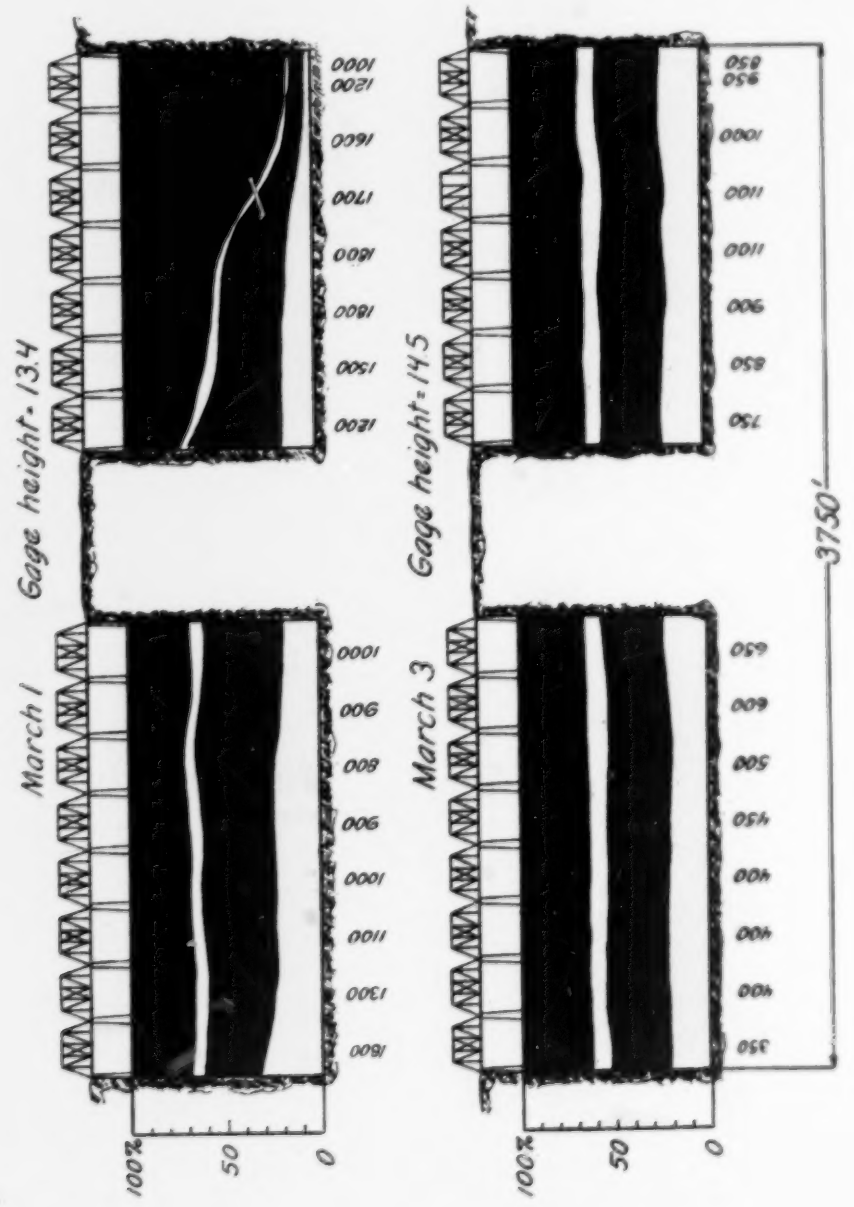
COMPLAINANTS' EXHIBIT No. 141.

Showing Color of Turbidity of Susquehanna River Water at Harris-
burg, Pa., in 1903.

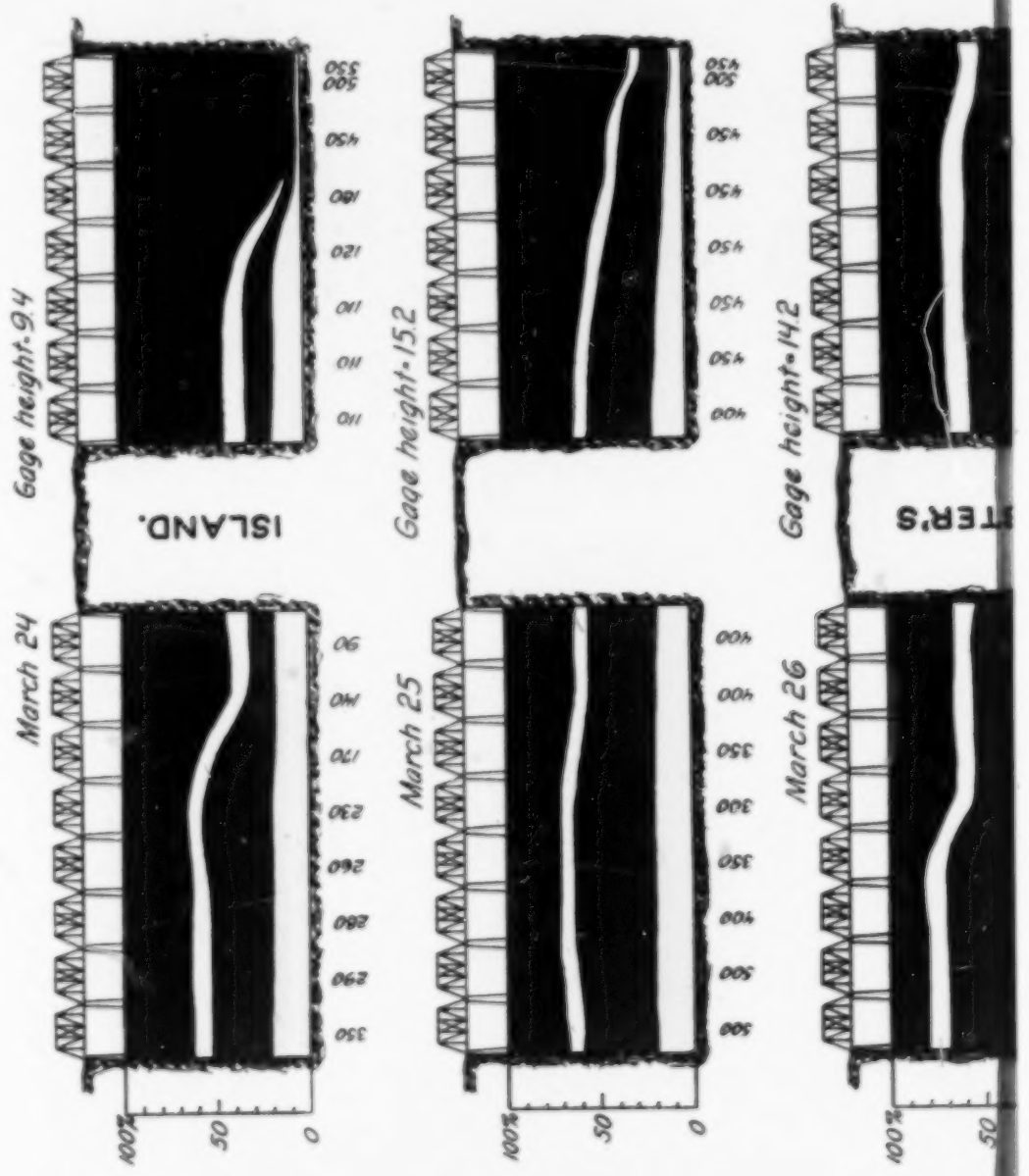
JAMES D. MAHER,
Commissioner.

*Augmented by info No. 141
James D. Maher
Commissioner*

FLOOD OF MARCH 1 1903.

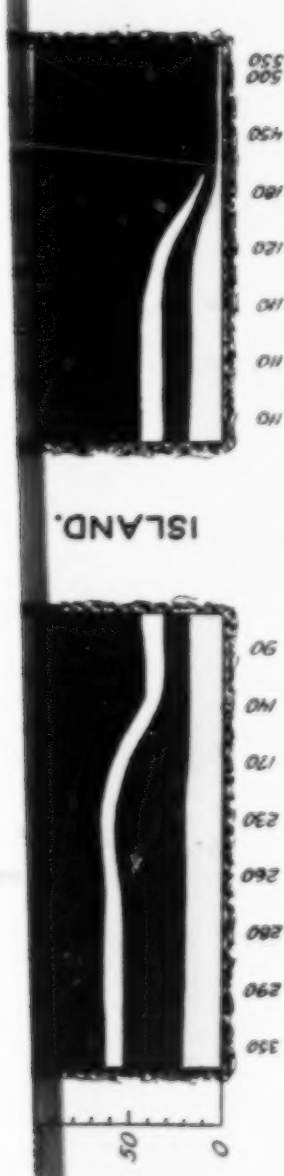


FLOOD OF MARCH 24 1903.



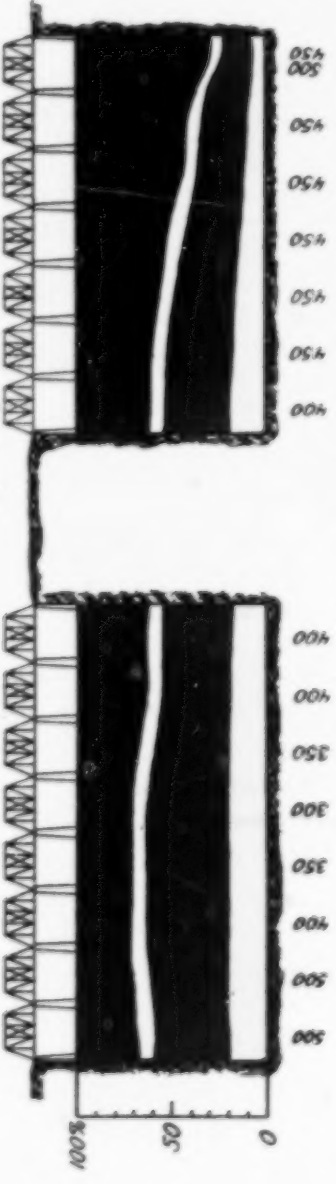
CUMBERLAND CO. SHORE

HARRISBURG SHORE.



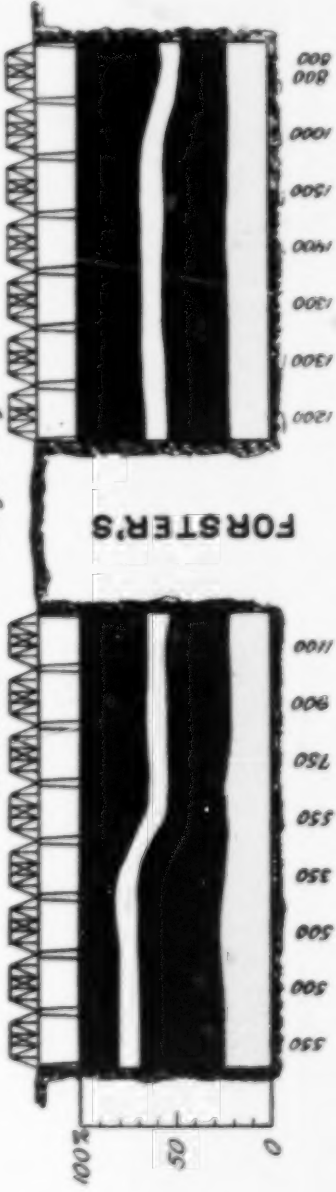
March 25

Gage height-152



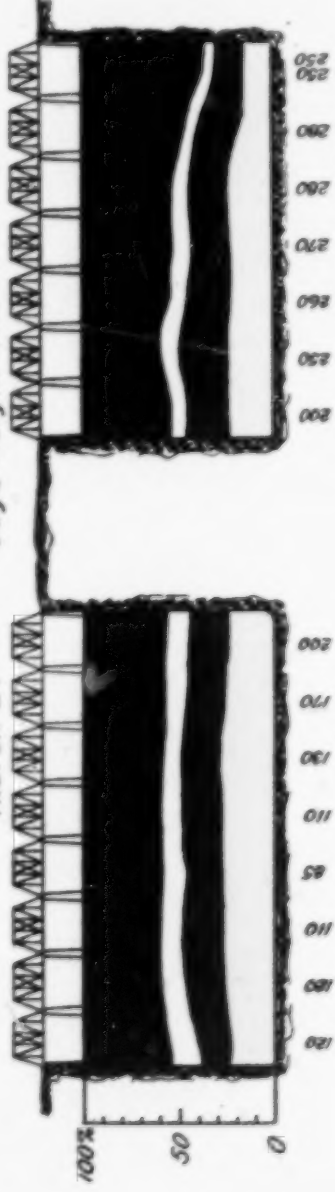
March 26

Gage height-142



March 27

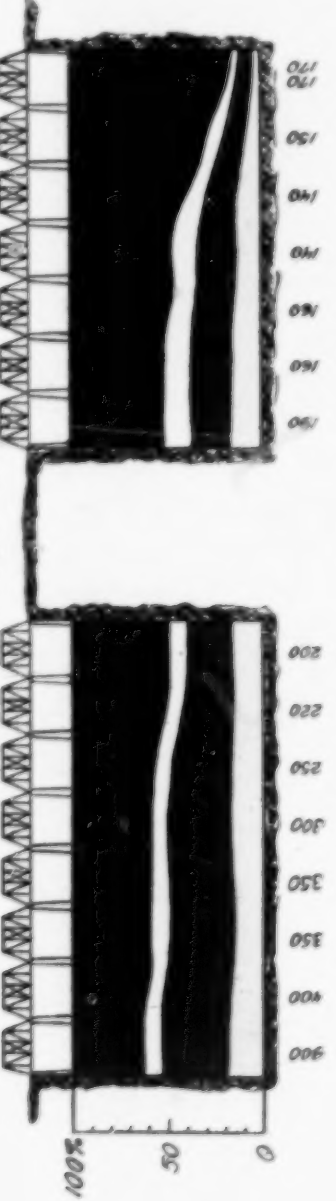
Gage height-110



FLOOD OF APRIL 16 1903.

April 16

Gage height-127



COLOR OF TURBIDITY OF SUSQUEHANNA RIVER WATER AT HARRISBURG PA. ON CERTAIN DAYS.

Samples taken under each span of Walnut Street Bridge
Component colors, black, red, yellow, and white, plotted in
percentages of fused color. Percentages obtained by color top.
Figures are silica turbidities.



THE PEOPLE OF THE STATE OF NEW YORK,
COMPLAINANTS,

VS.

STATE OF NEW JERSEY ET AL.

COMPLAINANTS' EXHIBIT No. 142.

Showing Map of Belfast Lough, Ireland.

JAMES D. MAHER,
Commissioner.

Compliments Exhibit No 102
James D. Maher
Commissioner



1 COMPLAINANTS' EXHIBIT No. 145. James D. Maher,
Commissioner.

NEW YORK CITY, May 19th, 1913.

This certifies that a copy of the within report has been filed in the Mayor's office by the Metropolitan Sewerage Commission.

JAMES MATTHEWS,
Executive Secretary.

Report on the Discharge of Sewage from the Proposed Passaic Valley Sewer of New Jersey.

Metropolitan Sewerage Commission of New York.

May 23, 1910.

Honorable William J. Gaynor, Mayor of the City of New York:

SIR: In a report submitted by this Commission to your Honor on March 1, 1910, reference was made to a number of proposed trunk sewers which will add materially to the pollution of the harbor by carrying the sewage of inland cities to the immediate vicinity of New York City for disposal. One of these sewers is that of the Passaic Valley Sewerage Commissioners, of New Jersey. To prevent the execution of the Passaic Valley project a suit is pending in the United States Supreme Court between the People of the State of New York, complainants, and the State of New Jersey and Passaic Valley Sewerage Commission as defendants.

The United States Government by permission of the Court became a co-plaintiff in this suit, but has recently entered into an agreement with the defendants whereby the objections of the Government have been removed. It is expected that this agreement will be followed by the withdrawal of the State of New York, thus permitting the construction of the Passaic Valley sewer and the discharge of its sewage after partial purification, into Upper New York Bay.

The Metropolitan Sewerage Commission has given close attention to the Passaic Valley project since 1906. The question was also studied by the New York Bay Pollution Commission from 1903 to 1906. The Pollution Commission objected to it in general and specific terms, and recommended that the State of New York bring action which is now pending in the Supreme Court of the United States to prevent the execution of the proposed works.

The plans for the works have been altered somewhat since this suit was begun, but they have not been wholly relieved of their objectionable features. The Metropolitan Sewerage Commission respectfully advises your Honor that the project as now announced should be opposed by the City and State of New York as involving serious danger of nuisance and injury to the public health.

Upon its face the present plan of the Passaic Valley Commis-

sioners appears to be a decided improvement upon the project formerly announced, but it is the opinion of the Metropolitan Sewerage Commission that the method of disposal is still objectionable. The degree of purification is insufficient. There are features connected with the outlets which are untried, experimental and of uncertain practicability. The agreement provides for the enforcement of the contract by the United States War Department instead of by the City or State of New York or an Interstate Commission, where jurisdiction over the sanitary condition of the harbor properly belongs.

Plan of the Passaic Valley Commissioners.

The proposition of the Passaic Valley Sewerage Commissioners is to collect the house drainage of Newark, Paterson, and about 30 other municipalities or townships in the Passaic Valley and discharge it into Upper New York Bay. This would be done by an extensive system of sewers and a tunnel running under Newark Bay, Bayonne and New York Bay to the neighborhood of Robbin's Reef. The tunnel would discharge the sewage through a number of outlets at the bottom of the harbor near the edge of the main ship channel. The sewage would be screened and passed through settling basins in order to remove solid particles of grit. The number of persons tributary to the sewer would be about 600,000 when the works were first put into operation. The quantity of sewage would increase with the population up to the full capacity of the sewer, when there would be about 1,650,000 people contributing their sewage to the works.

Insufficient Purification.

The purification intended would not be sufficient to admit of the discharge of the Passaic Valley sewage at Robbin's Reef. The process contemplated is designed solely to remove solid matters, and has no reference to the dissolved organic matters which may be present and from which a large part of the total nuisance may be anticipated. There will be little solid matter to be removed from the sewage. Owing to mechanical and biological actions in the sewer much of the solid matter will be broken up into extremely fine particles which will escape the screens and settling basins and pass into the harbor water.

Even the removal of a very large percentage of the suspended matter in the sewage would not purify the sewage to a satisfactory extent. Most of the organic matter in all sewage is present in dissolved form. Because of its long passage through the sewers the sewage will, in all probability, be in a septic, or rotten, condition and consequently very offensive.

Owing to its septic condition the sewage will have a great avidity for the oxygen dissolved in the harbor water, and the investigations of this Commission indicate that the supply of oxygen in the harbor is already deficient because of the sewage which is being discharged.

The discharge of so large a quantity of sewage into the harbor in one locality, even though the outlets be scattered over an area of several acres, would almost certainly result in the reduction of the dissolved oxygen at times of imperfect dispersion, and during times when the currents would be stationary or recently reversed, to so low a point as to invite putrefaction and the consequent evolution of foul odors from the water and sewage mixture. In this connection it should be remembered that the point of outfall would be in the land-locked part of the harbor, within sight of the most densely crowded business section of New York City within a distance of one mile of the Borough of Richmond and three miles of the Borough of Brooklyn.

Unusual Rights Apparently Granted by the United States Government.

The agreement entered into by the United States Government and the Passaic Valley Sewerage Commissioners contains the provision that the discharge of the sewage into the harbor at the locality chosen shall not reduce the available supply of dissolved oxygen in the water below the limit that would injuriously affect major fish life in the waters thereabouts. This provision apparently grants to the Passaic Valley Sewerage Commission the right to absorb all the margin of sewage capacity now remaining in the harbor waters, and opens the way to complications of a serious nature. The United States Government should not, and perhaps cannot legally grant to the Passaic Valley Sewerage Commissioners

4 the total or any definite proportion of the remaining capacity of the harbor waters to receive sewage.

Experimental Method of Discharge.

The method proposed for the discharge of the sewage beneath the surface of the harbor involves many constructional difficulties and uncertainties. It is not known that outlets of the form and character proposed can be constructed and maintained at the place designated. If, after the work on the tunnel shall have been partly or wholly completed, it be found that the system of outlets proposed cannot be built for the amount of money available, it is within the range of possibility that the plans now agreed upon would be changed to a simpler and less expensive form of construction to the material disadvantage of the method of disposal.

Extensive studies, including thousands of analyses, made by the Metropolitan Sewerage Commission concerning the quality of the water in Upper New York Bay, indicate that the discharge of sewage in the manner and in the quantities proposed by the Passaic Valley Commission would be attended by a heavy draft upon the capacity of the harbor for assimilating sewage. The quality of the water at the present time shows unmistakably the effects of the sewage now discharged into the harbor. The welfare of the cities situated upon the shores of the harbor requires that the water shall not be unnecessarily contaminated with the sewage of inland com-

munities. The burden of pollution should be increased only when strictly necessary, as where cities are situated on the water front and can provide no other method of disposal.

It is reasonably certain that a nuisance would appear at the outfall. The sewage from the Passaic Valley district cannot reasonably be expected to disappear without the production of local nuisance, including discoloration of the water, the appearance of greasy scum and offensive odors.

Availability of Other Methods of Disposal.

It is not the duty of the Metropolitan Sewerage Commission of New York to solve the problems confronting the Passaic Valley Sewerage Commissioners and state in detail what solution of this
5 question should be adopted, but the plan proposed by the Passaic Valley Commission is not the only one available for disposing of the sewage.

It would be better, in the judgment of the Metropolitan Sewerage Commission, for the sewage of the Passaic Valley district to be purified upon the Newark meadows and the effluent discharged into Newark Bay. There is a large movement of tidal water in Newark Bay, and the saving in cost which would be effected if it were not necessary to construct an outfall tunnel beneath Newark Bay, the Bayonne Peninsula and New York Bay, with the expensive system of outlets proposed, would go far toward paying the cost of purifying the sewage to an extent which would make the discharge of the effluent into Newark Bay a safe procedure.

The suggestion that the Passaic Valley sewage be purified on the Newark meadows and discharged into Newark Bay should not be interpreted as an expression of opinion by the Metropolitan Sewerage Commission favorable to the Passaic Valley enterprise in any of its aspects. The collection of the sewage of that large territory to a central point for disposal is not the only way in which the sewage problems of the Passaic Valley can be solved. It might be more desirable to collect and dispose of the sewage of the different municipalities concerned on some other basis, as, for example, by a number of sewerage districts and at a number of sewage disposal plants. Favorable reports upon such projects have been made by eminent engineers at the instance of the City of Paterson in the Passaic Valley district.

The Secretary of War as Referee.

The agreement entered into between the United States Government and the Passaic Valley Commission stipulates that the sewage would produce no effects objectionable to the Secretary of War of the United States, either through interference with the navigable character of the channels or through the production of nuisance or conditions injurious to the public health. The agreement mentioned does not give adequate assurance to the people of New York

City and State that the Passaic Valley project will not become a public nuisance, and the method of enforcing the agreement is open to criticism.

The agreement is between the Passaic Valley Sewerage Commissioners and the United States through the Secretary of War. The War Department is not a legal health authority and has no responsibility of a sanitary nature toward the State of New York or New York City. If the Passaic Valley sewage became a serious nuisance or menace to health to the people of New York City or State, it could not properly be objected to by the Secretary unless injury were done to the property of the United States Government. This property, including, principally, fortifications, is of insignificant character as compared with the interests of the City and State of New York.

Were the Passaic Valley sewage to produce a nuisance or substantial injury to the health of the cities situated upon the harbor of New York, there would be no way to stop the nuisance except by long and tedious litigation and the construction of extensive public works. Once the Passaic Valley sewer was built and in operation it would be impracticable to put a stop to the discharge of sewage through it, for the cities tributary to it would then have no other outlet for their offensive and dangerous wastes.

Action Recommended.

The present status of the Passaic Valley case is as follows: The State of New York brought suit against the Passaic Valley Sewerage Commission and State of New Jersey in the United States Supreme Court to prevent the execution of the Passaic Valley project. The United States Government requested and obtained permission to intervene in this suit and become a co-plaintiff in order to protect United States property in New York harbor against injurious consequences from the sewage. An agreement was thereafter entered into between the United States and the defendants whereby the latter agreed to purify the sewage to an extent and in a manner specified, on condition that the United States would withdraw from participation in the suit. This agreement has been ratified by the New Jersey Legislature and by the United States Attorney General. The suit still continues as between the State of New York and the defendants, but it is expected to be withdrawn unless continued for some unexpected reason.

The Metropolitan Sewerage Commission of New York recommends to your Honor that The City of New York take steps to assert its legal rights in the premises, and it is suggested that application be made to the United States Supreme Court for permission to intervene in the suit in order to become a co-plaintiff, to the end that public health and welfare in The City of New York shall be adequately protected.

A large amount of technical information bearing upon the capacity of New York harbor to assimilate and otherwise dispose of the sewage of the Passaic Valley, and data concern-

ing the probability of a nuisance from this source are contained in the report of the Metropolitan Sewerage Commission dated April 30, 1910.

Respectfully submitted,

METROPOLITAN SEWERAGE COM-
MISSION OF NEW YORK.

GEORGE A. SOPER, *President*.

JAMES H. FUERTES, *Secretary*.

H. DE B. PARSONS.

CHARLES SOOYSMITH.

LINSLEY R. WILLIAMS.

1 COMPLAINANT'S EXHIBIT No. 146. James D. Maher,
Commissioner.

NEW YORK CITY, May 19, 1913.

This certifies that a copy of the within report has been filed in the Mayor's office by the Metropolitan Sewerage Commission.

JAMES MATTHEWS,
Executive Secretary.

*Report on the Proposed Discharge of Sewage From the Bronx Valley
Sewer.*

Metropolitan Sewerage Commission of New York.

July 25, 1910.

Honorable William J. Gaynor, Mayor of The City of New York:

SIR: The object of this report is to recommend that The City of New York take action to prevent the discharge of crude sewage from the Bronx Valley sewer. The sewer is now in process of construction. It is intended to discharge its sewage into the Hudson River immediately outside of the New York City boundary. The plans are for works to accommodate the sewage of an ultimate population of 850,000 people.

The Metropolitan Sewerage Commission of New York brings the project of the Bronx Valley Sewer Commission officially to the attention of The City of New York and, after pointing out that the regular machinery of the State for the protection of public health has been made inoperative, recommends that The City of New York take such action through its legal department as may be necessary to safeguard the interests of its citizens in this matter. It is suggested that appropriate action lies in an application to the United States Supreme Court for permission to intervene in the suit of the United States vs. the State of New York and Bronx Valley Sewer Commission in the United States Supreme Court in order that The City of New York may become a co-plaintiff with the United States and have a voice in the proceedings.

Early Opposition to the Bronx Valley Sewer Project.

2 Permission for the construction and maintenance of the Bronx Valley sewer was given by special act of the New York Legislature approved May 26, 1905, and amended by subsequent acts.

Early opposition to the project was made by the Metropolitan Sewerage Commission of New York. In a letter dated September 18, 1906, the Metropolitan Sewerage Commission addressed a communication to the Chairman of the Bronx Valley Sewer Commission, pointing to the absence of provision in the Bronx Valley sewer plans for purifying the sewage before discharging it into the Hud-

son, showing the feasibility of purifying sewage, explaining the probable need of treating the Bronx Valley sewage, and recommending that provision be made in the plans for at least the minimum measure of treatment which future studies might show to be necessary. This communication led to conferences between the Bronx Valley Commission and the Metropolitan Commission, during which the subject was more fully discussed. The conferences were without result. The Metropolitan Commission had no authority to enforce its recommendations and it was impossible by other means to induce the Bronx Valley Sewer Commission to alter the plans.

At a hearing on the Bronx Valley project before the State Commissioner of Health and State Engineer and Surveyor in December, 1906, the Metropolitan Sewerage Commission registered official protest against the Bronx Valley sewer project on account of its failure to provide purification for the sewage before discharging it into the Hudson River. Under the general laws of New York State, all plans for sewerage and sewage disposal must receive the approval of the Health Commissioner and State Engineer and Surveyor before they can be carried out.

At the hearing just mentioned, protests were also made and petitions filed by organizations representing the entire trade and commerce of The City of New York. The civic bodies included the Chamber of Commerce of the State of New York, the New York Produce Exchange, the Maritime Association of the Port of New York, the Merchant's Association of New York, the New York Board of Trade and Transportation, the West End Association and the American Steamship Association.

These protests were without avail, for the State Engineer and the State Commission of Health had apparently been deprived of their usual functions with respect to this sewerage project. It was presently declared by the Attorney General of the State that the special act of Legislature under which the Bronx Valley Sewer Commission existed placed the operations of that commission outside the jurisdiction of the State Commissioner of Health and the State

3 Engineer and Surveyor. The Legislature had apparently given permission to the Bronx Valley Commission to discharge its sewage into the Hudson River without regard to consequences.

At the present time the State of New York is being compelled to defend the construction of the Bronx Valley sewer, having been placed in this position by the United States Government. A suit for a permanent injunction to prevent the construction and operation of the sewer is pending in the United States Supreme Court between the United States on the one side and the State of New York and the Bronx Valley Sewer Commission on the other. Pending trial of this suit, the work of constructing the sewer is being pushed rapidly. Because of the rapidity of construction and delays attending the suit, it is now proposed by the United States Department of Justice to apply to the United States Supreme Court for an injunction which will stop the work until the trial determines whether a permanent injunction shall be issued.

The suit brought by the United States against the State of New York and the Bronx Valley Sewer Commission is based on the injury which the Bronx Valley sewer is expected to do to property of the United States situated in New York Harbor, to the health of soldiers and sailors, and to the navigable channels which are the particular concern of the Government of the United States. The bill of complaint is a concise and conservative statement of the magnitude of the port, its importance as a commercial centre, the nature and cost of the harbor channels and other facts of interest in the case. A number of expert opinions with respect to the consequences to be apprehended are quoted from reports of United States Army officers of high rank and recognized sanitary experience. It is expected that arguments in the case will be heard in the autumn of 1910.

Necessity for Action by The City of New York.

Although likely to be seriously affected by the outcome of the case, The City of New York has, up to the present, taken no part in the legal proceedings against the Bronx Valley sewer project. The City has not been officially apprised of the situation or advised to take any legal steps in the matter. The time has now arrived when appropriate action should be taken. Information has come into the possession of the City to show the consequences which may reasonably be expected if the Bronx Valley sewage is discharged in the manner and quantity proposed. This information, collected by the Metropolitan Sewerage Commission is believed to be sufficient to make effective protest in a court of law.

The objections which are here made against the Bronx Valley sewer are similar to those already urged against the Passaic Valley sewer. The opinion of the Metropolitan Sewerage Commission concerning the Passaic Valley project has already been formulated and officially brought to the attention of the Mayor of The City of New York with the recommendation that the City become a co-plaintiff with the State of New York in a suit now pending in the Supreme Court at Washington, between the State of New York on the one side and the Passaic Valley Sewerage Commission and the State of New Jersey on the other, to prevent the discharge of sewage in accordance with the plans of the Passaic Valley Sewerage Commissioners.

The Bronx Valley and Passaic Valley projects belong to a class of drainage schemes to which the Metropolitan Sewerage Commission and its predecessor, the New York Bay Pollution Commission, have registered repeated protests. These protests have been made without respect to the governmental boundaries in which the sewers are built or within which they produce their worst effects. The chief ground for objection lies in the fact that such sewers are intended to carry to New York Harbor, already too heavily polluted with the sewage from the dense populations crowded upon its shores, large quantities of sewage from inland communities, which can provide other means of dealing with this waste.

Essential Facts Concerning the Bronx Valley Sewer.

The Bronx Valley project is of great magnitude. The total area in the assessment district is 35 square miles. The present population is about 30,000 and the ultimate population expected is 850,000. The daily discharge of sewage provided for at the commencement of operation is 3,000,000 gallons, and the ultimate discharge 90,600,000 gallons. The cost of the works, up to the time of opening, including expenses for land and incidentals, as estimated at \$2,250,000. The sewer will begin at the northern boundary of White Plains and pass through Scarsdale, Tuckahoe, Bronxdale and part of Yonkers and Mount Vernon. The diameter of the sewer at its upper end is to be 3 feet 4 inches and at its lower end 8 feet 6 inches. The sewer is intended to carry only household drainage. Storm water is to be excluded. The total length of the sewer is to be 14 miles. The outlet is to be about 300 feet north of the point where the northerly line of the City of New York intersects the Hudson river.

The outlet, as planned, is to consist of two lines of 48-inch cast iron pipe, extending to a point in the river 500 feet from the shore and 40 feet below the surface of the water.

The theory upon which the sewage is to be emptied into the river is that the sewage will be mingled with and dispersed by the water of the river with such speed and completeness as to disappear. Disposal beneath the surface in the manner proposed is an improvement upon discharge at the surface, but the Metropolitan Sewerage Commission is of opinion that the sewage would not satisfactorily disappear under the conditions stated.

Probably the best example in the United States of a large quantity of sewage discharged beneath the surface of tidal water is afforded at Peddock's Island in Boston harbor. Here 40,000,000 gallons of sewage per day is discharged through a single outlet located 30 feet beneath the surface. Contrary to the theory of immediate disappearance, the sewage at Peddock's Island rises at once and makes its appearance at the surface in a dense, discolored and offensive stream. The solid matters of the sewage rise with the liquid portion, particles of paper, fruit peelings and excrement being easily distinguishable. Traces of the sewage are sometimes visible for more than a mile.

Aside from the local nuisance which would be produced, the Bronx Valley sewage would add a considerable burden of impurities to the water which would have to be flushed away or assimilated by the water. As will be more fully explained, the flushing action of the harbor is incomplete and irregular. Most of the sewage which is discharged into it must be absorbed. The disappearance of the sewage depends upon the liquefaction and assimilation of the organic constituents. These processes are carried on largely through the activities of low forms of life natural to the water, such as bacteria and infusoria. When the quantity of sewage is so great as to overcharge the capacity of these agencies, disagreeable consequences

follow, notably discoloration of the water, evolution of foul odors and deposition of solid matter.

In New York harbor, deposits often occur near sewer outlets, and putrefactive changes, with the escape of offensive gases, take place.

When the Bronx Valley sewer is first put in operation, the solid matter in the sewage will reach 1,400 tons per annum. This amount will be increased to at least 36,000 tons when the capacity of the sewer is reached. In addition to this solid matter, large quantities of decomposing organic matter will be discharged in liquid form.

Present Sanitary Condition of New York Harbor.

The present condition of New York Harbor has been ascertained by studies, extending over several years, by the Metropolitan Sewerage Commission and the New York Bay Pollution Commission. Thousands of bacteriological and chemical analyses have been made of the waters at various depths, at all seasons and at practically all points. Studies of the tidal phenomena have been made and the intermixtures of ocean water and water brought down by the Hudson and other rivers have been determined daily for one year. Some of this work has been done in co-operation with the United States Coast and Geodetic Survey, experts of that branch of the government having, at the request of the Metropolitan Sewerage Commission, made an exhaustive research and compilation of all existing data in their possession relating to the direction of currents and the quantities of water flowing in and out of New York Harbor.

From these studies, the Metropolitan Sewerage Commission has deduced many facts with relation to the capacity of New York Harbor for sewage, the most important of which is that the harbor is far less capable of disposing of sewage in an inoffensive and sanitary manner than is commonly supposed.

Contrary to a belief now popularly held and formerly supported by apparently strong technical authority, the principal result of the movement of sea water in New York Harbor is to cause the sewage which is discharged into it to oscillate back and forth near the sewer outfalls. The harbor is not effectively flushed out by the tides. Aside from the water which is brought down by the Hudson and other rivers, there is practically no more water flowing seaward than landward. In certain parts of the harbor stagnation occurs. The condition of the waters in the open main channels makes it plain that sewage must be kept out of the harbor as far as it is practicable to keep it out.

The digestive capacity of the harbor for sewage has a limit. If this limit is passed, the water will become black, foul-smelling and putrid. Obnoxious gases will arise from it. In parts of New York Harbor such conditions as these now exist and are becoming more extensive as time passes. At present they are located for the most part in closely built-up factory sections, but their injurious effects extend beyond local limits, and contribute to the polluted condition of the whole bay.

It has been found that practically the whole of upper New York Bay and the lower Hudson are underlaid by an accumulation of foul-smelling, black ooze in which fragments of sewage origin are readily discoverable. These deposits are of considerable thickness, sewage matters having been brought up from a depth of ten feet below the surface of the mud.

As might be expected under the circumstances, the number of bacteria in the harbor water is excessive. While clean sea water generally contains not more than a few hundred bacteria per cubic centimeter, the polluted waters of New York Harbor contain thousands. The average of a large number of analyses shows that the number of bacteria in the lower bay is about 1,300 per cubic centimeter of water; in the upper bay about 14,500; in the Hudson River, opposite Manhattan, about 6,600; in the vicinity of the proposed outlet of the Bronx Valley sewer the average number of bacteria per cubic centimeter has been found to be about 5,300. Intestinal bacteria are to be found everywhere. The water north of the Narrows is unsuitable for the cultivation of shellfish and dangerous to bathe in. The collection of driftwood for fuel is attended by considerable risk of disease.

The condition of the water with respect to its capacity for absorbing sewage without producing great offense is well indicated by the quantity of dissolved oxygen which the water contains. Sewage draws upon the oxygen supply, and when the oxygen in the water is exhausted the organic matter in the water putrefies. While clean sea water and uncontaminated river water normally contain 100 per cent of oxygen, the water of upper New York Bay contains but 67 per cent.; the Hudson River, opposite Manhattan, 72 per cent.; and the water near the proposed outlet of the Bronx Valley sewer, 83 per cent. of the quantity of oxygen which it should have.

The movement of the main tidal currents which oscillate backward and forward in New York Harbor has been well shown by floating objects which have been set adrift by the Metropolitan Sewerage Commission. There have been over seventy experiments of this kind. Some of these floats have been followed day and night by means of boats. One such float was started at the beginning of an outflowing tide on November 10, 1909, at 8.25 A. M., at Spuyten Duyvil, about three miles nearer the ocean than the proposed outlet of the Bronx Valley sewer. It flowed up and down in the Hudson, back and forth in the Upper Bay and to and fro in the Narrows until, on November 12, at 2.20 A. M., it had reached a point opposite Coney Island in the Lower Bay. Three times the direction had been reversed by the currents. For two days the float had drifted about the harbor. It had covered a total distance of $63\frac{1}{4}$ miles, while the direct distance from start to finish was $24\frac{1}{2}$ miles. The conditions on this occasion were by no means unusual. The float was started at a stage of tide which was distinctly favorable to a prompt and direct passage to sea.

Summary of Objections to the Bronx Valley Sewer Project.

The objections which careful inquiry has shown to exist with respect to the Bronx Valley project are numerous and cannot all be stated here. Perusal of the foregoing pages will show their general nature. For convenience, a few of the main considerations which are opposed to the discharge of crude sewage from the Bronx Valley sewer follow:

1. The project would increase the pollution of the harbor as a whole and add materially to the pollution of that part of it where the sewer would discharge.

2. The proposed outlet is so near the New York City line that property in the city would be as surely affected as if the sewer was made to discharge within the city limits. Being outside of its boundaries, the City of New York would have no jurisdiction over the outlet.

3. Land in the neighborhood of the outlet is occupied by high-class residences and by large philanthropic institutions, chiefly homes for children. It is estimated that one thousand children reside in the neighborhood of the proposed outlet.

4. At the present time, sewage from the City of Yonkers, discharging about a mile above the proposed outlet of the Bronx Valley sewer, can sometimes be seen flowing down the Hudson in a stream for several miles. The sewage from the Bronx Valley sewer would increase this sewage stream and add to the consequent dangers and annoyances.

5. Objections to the Bronx Valley project exist in the fact that it is opposed to the policy of protecting the harbor which has been officially formulated by the State and City of New York through the Metropolitan Sewerage Commission.

6. In all the ways in which the pollution of the Hudson River and New York Harbor may affect public health and comfort, the discharge of sewage from the Bronx Valley sewer would be an aggravating and growing factor.

7. Objection against the discharge of crude sewage from the Bronx Valley sewer exists for the reason that it would benefit one section of the metropolitan district at the expense of others. It should be a subject of mutual effort to keep the harbor clean as it is a matter of importance to all the people of the metropolitan district, in a part of which the Bronx Valley sewer is located. The City of New York, the chief offender against this policy as matters have stood in the past, is taking active steps to deal with its sewage in a sanitary manner.

8. The first step toward the protection of the harbor was taken by The City of New York when the Metropolitan Sewerage Commission was created to make an official study of the conditions of sewage disposal, and formulate a general plan or policy of conservancy for the metropolitan district of New York and New Jersey without respect to state or municipal lines. This investigation, made with strict impartiality, and involving the study of conditions outside as

well as inside of the limits of New York City, was paid for by The City of New York for the common good.

A second step taken by New York City for the protection of the harbor was made when the Legislature, at the request of the City, extended the life of the Metropolitan Sewerage Commission from May 1, 1910, to May 1, 1913, in order for it to make plans and estimates for the works necessary to protect the harbor as far as practicable from the sewage of New York City.

9. Objection to the Bronx Valley project exists for the reason that the evil consequences which will result will not be occasional or temporary, but continuous and increasing. The quantity of sewage will become greater as time proceeds, but the quantity of water into which it will be discharged will remain always the same. It is well within the range of probability that the estimates of future population of the Bronx Valley sewer district are too low, and that the remarkable growth of population now taking place in all parts of the suburbs of New York will make necessary a parallel sewer through the Bronx Valley, which will greatly increase the expected quantity of sewage discharged at the proposed outlet.

10. Objection to the Bronx Valley project arises from the fact that if no means for purifying the sewage are now provided, or land procured for the same, such works may prove impracticable
10 to construct or locate in future without incurring greater expense than the residents of the Bronx Valley district are able to meet.

11. The Bronx Valley Commission cannot lay claim to unexpected insistence upon the purification of its sewage. They were notified by the Metropolitan Sewerage Commission in 1906 that they should make provision for such purification works as might eventually be found necessary.

12. Objection to the Bronx Valley project lies in the fact that special legislation took from the State Department of Health the jurisdiction which the general laws of the State intended that department to exercise over all questions of sewerage and sewage disposal. The State Department has, within recent years, made commendable efforts to protect the purity of the rivers of the State, yet the discharge of the Bronx Valley sewer, intended ultimately to dispose of a larger quantity of sewage than is produced by some of the cities of the State, is beyond the control of any sanitary authority.

Respectfully submitted,

METROPOLITAN SEWERAGE COMMISSION
OF NEW YORK.

GEORGE A. SOPER, *President*.

JAMES H. FUERTES, *Secretary*.

H. DE B. PARSONS.

CHARLES SOOYSMITH.

LINSLEY R. WILLIAMS.

COMPLAINANTS' EXHIBIT No. 147. James D. Maher,
Commissioner.

NEW YORK CITY, May 19, 1913.

This certifies that a copy of the within report has been filed in the Mayor's office by the Metropolitan Sewerage Commission.

JAMES MATTHEWS,
Executive Secretary.

Preliminary Reports on the Disposal of New York's Sewage.

I.

Study of the Collection of the Sewage of New York City to a Central Point for Disposal.*

Metropolitan Sewerage Commission of New York: George A. Soper, James H. Fuertes, H. de B. Parsons, Charles SooySmith, Linsly R. Williams, Commissioners.

SEPTEMBER, 1911.

- 1 Study as to the Feasibility and Desirability of Collecting the Sewage of New York City at a Central Point for Disposal.

It has occasionally been suggested by engineers and others who have recognized the need of stopping the pollution of New York harbor that all the sewage be collected into one system of main drainage and pumped out to sea.

The benefits which would accrue from this solution of the sewage problem are so apparent that the Metropolitan Sewerage Commission of New York has given serious attention to the practicability of such a project. The following report is intended to describe the essential engineering features of the four forms of this general project which have seemed to the Sewerage Commission most promising. It would be within the range of engineering ability to carry out any of them, but the Commission considers that the benefits which would be secured would not be sufficient to justify their cost.

The point suitable for the outlet of a sea-going tunnel would depend upon the quantity of sewage to be discharged and the uses to which the neighboring shore might be put. The larger the quantity of sewage to be disposed of, the farther the outlet should be from land. Other considerations affecting the location are the condition of the sewage with respect to the solid matter contained, the presence or absence of putrefaction, the action of the tidal currents and the uniformity or intermittency of discharge.

* This report is issued in advance of the final report of the Metropolitan Sewerage Commission in order that the contents may be of early service. Some features of this report will remain open for revision until the final report is submitted.

The territory which might appropriately be included in a drainage system whose object was disposal of the sewage at sea could apparently include the metropolitan district of New Jersey as well as New York. No insuperable reason is apparent why the two states should not unite in the construction of a single system of main drainage. The quantity of sewage to be disposed of would therefore be the quantity which would be produced in New York and New Jersey within about twenty miles of the New York City Hall.

Either Long Island Sound or the Atlantic Ocean might seem to afford a suitable site for the discharge of the sewage. There is, however, no point in Long Island Sound, within reasonable distance, where the waters are sufficiently open and where the outlet could be sufficiently far from inhabited shores to make the discharge of such a large quantity of sewage free from objectionable consequences. The extensive use of the bottom of Long Island Sound for the cultivation of oysters also makes these waters unsuitable. The Atlantic Ocean would be the only place which would be suitable for the discharge

of the sewage. The condition of the sewage would neither
2 favor nor hinder its prompt disappearance. The largest solid materials would be removed by screens for the protection of the pumps which would be required to force the sewage to the outlet, and some solid matter would be broken up by the passage of the sewage through the sewers, so that the matters left in suspension would be in finely divided condition.

The length of the sewers would be so great that the sewage would be in a state of decomposition by the time it reached the outlet and would therefore be more offensive than fresh sewage. In consequence of this fact, the water in the vicinity of the outlet would be more offensively polluted than it would be were the sewage to be discharged in fresh condition. The distance of the outlet from the shore should be correspondingly greater.

Just how far the outlet should be from shore is not susceptible of exact determination. From six to ten miles seems not too great a distance in view of the re-entrant angle formed by the coast line and the large number of residences and summer resorts along the beaches.

Continuous Discharge at Sea.

Experience shows that the sewage would mingle slowly with the sea water. It would, in all probability, rise in a column from the outlet at the bottom and flow away at the top, its destination as sewage being determined partly by the tidal currents, partly by the force and direction of the wind and partly by the intermixing action of the waves.

Studies have been made by the Sewerage Commission of the tidal currents and effects of wind at sea near the location which might be selected for the outlet. Opportunity to investigate this subject was afforded in the year 1906, when the garbage of New York City was being dumped at sea during a temporary suspension of the reduction plant at Barren Island, where the garbage is customarily dealt with. The point selected for sea-dumping of garbage was seventeen miles

southeast of the fairway buoy at the entrance of Gedney Channel. This point was about fifteen miles from the New Jersey and New York shores. Inspectors employed by the Sewerage Commission examined the beaches over a period of some weeks and investigators for the Commission cruised about upon the waters to note the presence and distribution of the refuse.

It was found that the garbage remained in flocs or fields for long periods of time. It traveled at rates approximating a maximum of two miles an hour under what appeared to be normal conditions of wind and tide. There was a distinct fouling of the shore lines over a distance of fifty miles from New York along Long Island and seventy-five miles along the New Jersey coast. Some
3 of the floating material returned to New York and was found moving into the inner harbor through the Narrows.*

Wind undoubtedly had an effect upon this floating refuse, but wind would also have an effect upon the movement of sewage. Wind moves the whole surface of the water upon which it blows, as has frequently been observed by the Commission in studying the behavior of sewage in Upper New York Bay.

An examination of the depths of water along the New York and New Jersey coast lines, as recorded upon the official charts of the United States Coast and Geodetic Survey,† shows that there is no point available at a distance of ten miles from shore where a sea-going tunnel could well be built. As the bottom for the most part is sandy, a tunnel would have to be built by compressed air. The depths required would exceed 120 feet, which is about the limit at which it is practicable to use the process. There would be serious difficulties, although not insuperable ones, in the construction of any long tunnel to sea.

From considerations of cost, excessive depth and magnitude of construction, the plan of carrying all the sewage of New York and New Jersey to sea is considered by the Sewerage Commission to be impracticable.

If New Jersey were left out of the project and New York undertook to discharge its own sewage at sea, the engineering problems would be somewhat simplified, but they would not be reduced to the range of practicability. The quantity of sewage would be approximately four-fifths of that of the entire territory. The tunnels could be fewer in number and the distance of the outlets from the shore less, but the general nature of the works and the difficulties of construction would be similar. The construction of the sea-going tunnel and its outlet would still be a great obstacle.

Discharge at Sea on Outgoing Tidal Currents.

The length of the sea-going tunnel could be materially shortened if the sewage could be stored temporarily on shore and discharged only on outgoing tidal currents. In this case the full benefit of the

* Report Metropolitan Sewerage Commission of New York, April 30, 1910, pp. 386-388.

† Chart No. 120, United States Coast and Geodetic Survey.

transporting power of the water as it moved from the land could be utilized to carry the sewage as far away as possible.

This modification or any other departure from the plan of a continuous sea-going sewage discharge has seemed to make it necessary to exclude New Jersey sewage from consideration. It has
4 seemed unwise to the Sewerage Commission to suppose that the people of New York would consent to receive New Jersey sewage for disposal on New York soil, or vice versa.

Considering that New York's sewage was alone to be disposed of and that the discharge at sea was to take place only on outgoing currents, it is considered by the Sewerage Commission that the outlet could be located within about five miles from shore. A point suitable for departure from shore would be in the vicinity of Rockaway Point, with storage basins situated in the neighborhood of Barren Island. Because of the necessity for discharging intermittently, the tunnel capacity would have to be larger than would be required for continuous discharge.

It has been estimated that the quantity of sewage to be disposed of in 1940 would be 1,330,000,000 gallons per day. (See Appendix A.) This would be discharged in two periods of four hours each. The storage basins and pumping station would have to cover an area of 125 acres and have a depth of 20 feet to store the sewage during the periods when suitable seaward-moving currents were not flowing. There could be 4 tunnels of 18 feet diameter each. The tunnels could run parallel to one another until near their outer ends, when they would separate to some extent. (See Appendix B.)

To collect the sewage to the vicinity of Rockaway Point for disposal at sea, there would be need of a system of collecting and intercepting sewers running to all parts of New York City. Staten Island would be connected by a tunnel beneath the Upper Bay. Manhattan would be provided with intercepting sewers running around the water front. The sewage would pass under the East River to large collecting sewers which would thence flow in the direction of the storage reservoirs near Barren Island. The sewage of Brooklyn would be collected by interceptors and collectors. A branch would run to The Bronx and another to a central point to take in the sewage of Northern Queens from the vicinity of Flushing. The sewers of this main drainage system would be of large magnitude, some of them approaching the dimensions of rapid transit subways.

To a large extent the present sewerage systems which receive the sewage directly from the houses would be utilized. The object of the main drainage works would be to collect the sewage from these sewerage systems and carry it to the disposal works.

As far as estimates have been made, it appears that the plan of collecting the sewage of New York to a central point and discharging it at sea on outgoing currents should not be recommended because of its cost. It is believed that the works would cost not less
5 than \$140,600,000. (See Appendix B.) It is possible that

such works may be needed in the remote future, but for the

present their large cost does not seem to be justified by the benefits which they would confer.

Application of the Sewage to Farm Land.

If the sewage of New York was collected to a central point for disposal, it could be dealt with in other ways than by discharge at sea. The sewage could be utilized by employing it for agricultural purposes or it could be purified to such a degree that the effluent would be non-putrescible and harmless. The Commission does not consider that either of these two latter plans is necessary or desirable, but it may be well to refer to some facts which should be taken into consideration in discussing the feasibility of these two procedures. Many persons have favored disposal on land, assuming that the sewage could in this way be turned to profitable use instead of being wasted. Intensive purification also has its advocates. The remarkable progress which has been made in employing bacteria and other agencies to carry on the purification of water and sewage under conditions which could be controlled lends considerable interest to this subject.

Considering first the possibility of applying the sewage to farm land, it is necessary to determine where the sewage of New York could be carried for disposal and how much land would be needed.

If the sewage of New York was to be disposed of on soil within the State, it would have to be taken to Long Island, for there is no other land within reach which has a suitable elevation and is of suitable quality. Long Island is low, flat, sandy and accessible.

To carry the sewage to Long Island for disposal on land, it should be collected first to a central point and from there pumped to the irrigation fields. A suitable central point would be in the vicinity of Jamaica. A system of main drainage including collectors and interceptors to carry the sewage which had been gathered by the lateral sewerage systems of the Metropolis would lead to a main pumping station. From the pumping station conduits would be needed to carry the sewage to the disposal fields. It would probably be economical to construct three such conduits with a diameter of 19 feet each. The fields might begin in the vicinity of Amityville, a distance of about thirty miles from the New York City Hall. Any point nearer would be unsuitable for the disposal of a large quantity of sewage because of the numerous villages, towns and other suburban settlements which exist.

About 175 square miles of land would be needed on the assumption that 12,000 gallons of sewage could be utilized per acre per 24 hours. This is the highest rate which should be allowed. A tract of suitable elevation and of proper quality of soil can be found running from Amityville to Quogue, a distance of about fifty miles.

From an engineering standpoint, the idea of applying sewage to the sandy soil of Long Island is feasible. It is estimated that the cost of the works necessary would be about \$153,000,000. (See

Appendix C.) The purchase of the land would add greatly to the above cost.

There are apparently insuperable obstacles to the successful carrying out of this project. Aside from the great cost of works and of land, it would be necessary to eliminate villages and towns and to acquire the right to the property of many large estates and public institutions or provide a larger total area than that mentioned. More important still, a part of the water supply of New York might be seriously interfered with. A large part of the drinking water for Brooklyn is obtained from wells on the south side of Long Island, and it seems improbable, even if no injurious consequences followed to the water, that public opinion would permit the sewage of the Metropolis to be disposed of on the same land from beneath which the water was derived.

Passing now from a consideration of the feasibility of disposing of the sewage upon farm land to the possibility of dealing with it by intensive purification, we may take up the last problem of handling the sewage after collecting it to one central point.

Intensive Purification of the Sewage.

For disposal by intensive purification, the sewage would be brought to a central point by a system of main drainage, including such collectors and interceptors as have already been sufficiently described.

The place to which the sewage would be brought could conveniently be the vicinity of Jamaica Bay.

The process of purification would presumably be settlement for the removal of the larger solid impurities and biological treatment for the oxidation of the dissolved organic matters. If the effluent, after purification, was to be discharged into the waters of Jamaica Bay or near the shore of the ocean, it could be disinfected so that it would practically, if not completely, be free from disease germs.

It seems unnecessary to describe the details of the purification which should be employed. It is well within the range of engineering ability to construct the works and to produce an effluent of any required degree of purity. Estimates have been made of the cost of intensive treatment, assuming that disinfection would not be necessary, but that settlement followed by oxidation in sprinkling filters would be the most desirable process. The collection and treatment works would cost approximately \$141,000,000. (See Appendix D.)

This sum, in the opinion of the Sewerage Commission, is a very large price to pay for the results which would be accomplished. It is, in the Commission's view, unnecessary at the present time to construct such a complete system of main drainage as would be required in order to collect all the sewage of the Metropolis to one central point.

Desirability of Subdividing the Territory for Sewage Disposal.

The plan of collecting all the sewage to a central point for disposal is, fortunately, not the only way to protect the harbor against

sewage pollution. It is the opinion of this Commission that works of less magnitude and cost can be constructed to answer all the requirements of the harbor, as a whole, and with special regard to the needs of certain localities.

Fundamental to the design of such large sewers, treatment works and outlets as are required, is a division of the metropolitan territory of New York into districts. The boundaries of these districts should coincide approximately with the principal natural drainage areas of the land. The sewage should be collected and treated in each of these districts in such ways as to afford all the relief needed for the near future, and their design should be such as to fit into a more comprehensive plan, if more protection is needed at a distant time.

The division of the metropolitan territory into districts, the manner and extent of the protection proposed for the waters of the harbor, and the cost of the drainage and disposal works will be the subjects of special reports to be submitted by this Commission as rapidly as the progress of the investigations permits.

Review and Conclusions.

Reviewing the various subjects dealt with in this report and combining the main facts and opinions for convenience of review, the following subjects seem to this Commission to be of special interest:

1. Although not necessary, it is within the range of engineering ability to collect all the sewage of the metropolitan district of New York and New Jersey to a central point for disposal.

2. The sewage of New Jersey, as well as that of New York, should be collected to a central point only in case the sewage is to be discharged at sea continuously and not exposed upon or above the surface of the ground.

3. It would not be desirable, from engineering considerations and on account of the cost, to discharge continuously all the sewage of the New York and New Jersey metropolitan district at sea, nor the sewage of New York at sea during all stages of tide.

4. The sewage of New York could be intermittently discharged at sea through tunnels, by employing storage basins and allowing the sewage to flow away on outgoing currents. The cost seems to make this plan prohibitive.

5. The sewage of New York could be carried to Long Island and disposed of on land, so far as engineering considerations are concerned, but the cost would not be justified.

6. The sewage of New York could be purified at one point so as to be inoffensive and without serious chance of harm to health. The works would cost what seems to be an excessively large amount of money.

7. The cost of collecting the sewage to one point and disposing of it intensively would be smaller than the cost of applying the sewage to land, but it would still be so great as to make the project appear to be inadvisable.

8. At some remote time, it may be necessary to collect all the sewage of New York to a central point for treatment or discharge at sea. This fact should be kept in mind in laying out such systems of main drainage and treatment as may be necessary for the present and near future.

9. The plan of collecting all the sewage to a central point seems to be unnecessary for the reason that other remedies, costing less money and involving fewer engineering and sanitary difficulties, appear to be more suitable. These remedies lie in dividing the City of New York into districts, determined chiefly by natural drainage areas, and providing main sewers and proper methods of disposal for each. The boundaries of these districts and the way in which this Commission proposes to deal with them will be the subject of future reports.

METROPOLITAN SEWERAGE COMMISSION.

GEORGE A. SOPER.

JAMES H. FUERTES.

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LINSLEY R. WILLIAMS.

9

APPENDIX A.

Revised Estimates of Population and Sewage Flow.

The following revised estimates of population and sewage flow of New York City in 1940 were made after the results of the United States census enumeration of 1910 became available. This was subsequent to the publication of the report of the Metropolitan Sewerage Commission, dated April 30, 1910.

Population.

The estimated population of New York City in 1940, as given in the report of the Metropolitan Sewerage Commission, dated April 30, 1910, on page 144, was 8,666,100. This result was reached after a careful study of population data available at the time. From curves drawn to show the probable future growth of population in each of the boroughs from which this total was made up, the estimated population of the City in 1910 was found to be 4,600,000. The U. S. census of 1910 gave the population of New York City as 4,766,883, indicating that the actual rate of growth in the city had been somewhat greater than that assumed in the estimates made by the Commission.

In view of this fact, and after full consideration of the subject, it was decided to take 9,000,000 instead of the earlier estimate of 8,666,100 as the approximate population of New York City in 1940.

In Table 1 of this appendix will be found summarized by boroughs the estimate of population of New York City in 1910, as made by

the Commission prior to April 30, 1910; the population as determined by the U. S. census in 1910; the estimated population in 1940 as made by the Commission prior to April 30, 1910, and the revised estimates of population in 1940, as made subsequently.

Volume of Sewage Flow.

The estimated volume of sewage flow of New York City in 1940, as given in the report of the Commission, page 146, was 1,580,000,000 gallons per 24 hours. Information obtained subsequent to the publication of the report made it seem advisable to reconsider this estimate and, as a result, new estimates were made. These gave 1,330,000,000 gallons per 24 hours as the total estimated volume of sewage flow of New York City in 1940.

The following facts led to the making of the new estimate:

1. Definite knowledge as to the population in New York City in 1910, the returns of the U. S. census of 1910 having become available.
2. More definite information as to the probable total water consumption and water consumption per capita in New York City in 1910, figures of the water consumption in 1909 having become available, from which, with definite knowledge as to population, a reasonably close estimate could be made of the probable water consumption in the City in 1910.

3. Figures from the Board of Water Supply giving their estimate of the future population and total water consumption in each of the boroughs of New York City in 1940.

In Tables 2, 3, 4 and 5 of this appendix are given the estimate of the volume of sewage flow in New York City in 1940 made by the Commission prior to April 30, 1910, the revised estimate made subsequent to April 30, 1910, the estimated water consumption in New York City in 1910 and the estimate of the population and water consumption in New York City in 1940 made by the Board of Water Supply.

TABLE 1.
Estimated Population in New York City in 1910 and 1940.

Borough.	Estimated population in 1910.	Population by V. N. census of 1910.	Estimates of population in 1940 by M. S. C. Report of	
	M. S. C. Report of 1910, p. 128.		1910, p. 144	As revised chap. 13, 1910.
Manhattan	2,399,000	2,331,542	4,143,200	3,000,000
The Bronx	354,000	136,080	979,000	1,200,000
Brooklyn	1,740,000	1,631,351	2,730,100	3,200,000
Queens	256,500	281,011	682,400	870,000
Richmond	83,500	85,069	131,400	130,000
Total	4,300,000	4,765,853	8,665,100	9,400,000

TABLE 2.

Estimated Volume of Sewage Flow in New York City in 1940 as Given in the Report of the Metropolitan Sewerage Commission Dated April 30, 1940.

Borough.	Estimated population in 1940. M. S. C. Report of 1940 page 144.	Estimated volume of sewage flow in 1940.		Corresponding volume of sewage flow in gals. per capita per 24 hours.
		M. S. C. Report of 1940, page 146. Mgd.*		
Manhattan.....	4,143,200	650	157	
The Bronx.....	979,000	195	199	
Brooklyn.....	2,730,100	500	205	
Queens.....	682,400	145	213	
Richmond.....	131,400	30	228	
Total.....	8,665,100	1,580	182	

* Million gallons per day of 24 hours.

TABLE 3.

11 *Revised Estimate of Volume of Sewage Flow in New York City in 1940 as Made by the Metropolitan Sewerage Commission, Submission Number 10, April 30, 1940.*

Borough.	Estimated population in 1940	Estimated volume of sewage flow in 1940		Corresponding volume of sewage flow in gals. per capita per 24 hours.
	As revised Oct. 12, 1940	Levised.	Mgd. ^a	
Manhattan.....	3,000,000	783		162
The Bronx.....	1,200,000	150		132
Brooklyn.....	3,200,000	426		133
Queens.....	870,000	138		159
Richmond.....	130,000	24		185
Total.....	9,000,000	1,330		148

^a Million gallons per day of 24 hours.

TABLE 4.
Estimated Water Consumption in New York City in 1910.

Borough.	Population by U. S. Census of 1910.	Rate of increase in population per year.	Total estimated water consumption.		Estimated water consumption in 1910.
			1909. ‡	1910. †	
		Per cent.		Mgd. *	Gals. per capita per 24 hours.
Manhattan	2,331,542	2.6	297	305	131
The Bronx	430,980	11.49	36	40	93
Brooklyn	1,634,351	4.01	154	160	98
Queens	284,041	8.56	27	29	102
Richmond	85,969	2.83	8	8	93
Total	4,769,883	3.87	522	542	114

* Million gallons per day of 24 hours.

† Derived from figures for the year 1909, assuming that the consumption of water increased at the same rate as the population.

‡ Estimate of W. W. Brush, Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, New York City.

TABLE 5.
Estimate of Population and Water Consumption in New York City in 1940, Made by the Board of Water Supply.

Borough.	Estimated population in 1940 §	Total estimated water consumption in 1940. §		Estimated water con- sumption in 1940.
		Mgd.*	Gals. per capita per 24 hours.	
Manhattan.....	3,000,000	480	160	
The Bronx.....	1,316,000	165	125	
Brooklyn.....	3,823,000	470	123	
Queens.....	924,000	116	126	
Richmond.....	195,000	24	123	
Total.....	9,258,000	1,255		136

* Million gallons per day of 24 hours.

† Figures furnished by A. D. Flinn, Department Engineer, Board of Water Supply, New York City.

APPENDIX B.

Discharge of New York's Sewage at Sea.

This project has for its aim the disposal at sea of all the sewage from New York City. The sewage would be collected by means of long, intercepting sewers all leading to one central point near Rockaway Inlet at the ocean entrance to New York harbor, where a pumping station and large retaining reservoirs would be located.

This project involves the discharge of the sewage intermittently at sea at a point about five miles southeast of Rockaway Point and during the first four hours of each outgoing tide. The sewage would be pumped continuously to the retaining reservoirs.

The estimated cost of the above project is \$140,600,000. It would care for 1,330 million gallons of sewage per 24 hours. It is estimated that there will be a dry weather flow of sewage from a population of 9,000,000 persons in the year 1940.

The estimate of cost given above is, at the best, but a very rough approximation and should be considered only as such.

Sewers.

In order to carry the sewage to Barren Island, five main sewers would be built, as follows:

Richmond-Brooklyn Line.

Manhattan-Brooklyn Line (West).

Manhattan-Brooklyn Line (East).

Bronx-Queens-Brooklyn Line.

Queens-Brooklyn Line.

Pumping Stations.

In addition to a main pumping station near Rockaway Inlet, pumping stations would be required at one or more points on each of the five main sewers or their branches.

It is assumed that the maximum capacity of the pumps in each station would be 50% in excess of what may be termed the average capacity; in addition to this a reserve capacity has been provided.

Storage Reservoirs.

It is assumed that the sewage would be stored during a period of 8 hours and that the volume so stored would be discharged at sea during the subsequent 4 hours, together with the sewage reaching the central pumping station during this latter period.

It is assumed that 50% of the average daily flow of 1,330 million gallons might reach the central station during a period of 8 hours. To store this volume of sewage, reservoirs having a capacity of 665 million gallons would be required.

With a depth of 20 feet, the reservoirs would have a net area of about 102 acres; allowing about 25% additional for walls embankments, pumping station, etc., or, say, 23 acres, the total area required at the sewage station would be about 125 acres.

Outfall Tunnels.

It would be very desirable, both on account of obtaining the most favorable conditions at the points of outlet and of minimizing the number of large and costly tunnels, to make both discharges of the day of equal volume without enlarging the capacity of the reservoirs beyond a size necessary to store the maximum flow for any 8-hour period of the day. By a proper method of operation this can be done, the conditions of pressure under which the two daily discharges take place being made very nearly the same. One-half the average daily sewage flow, or 365 million gallons, will therefore be outlletted during each 4-hour period.

The average rate of discharge through the tunnels would be:
 $665 \times 24 / 4 = 3,990$ million gallons per 24 hours.

To discharge at the above rate with a velocity of 6 feet per second, a tunnel capacity equivalent to that afforded by 4 tunnels 18'-0" in diameter would be required.

The velocity at the beginning and ending of discharge would be 7.5 and 4.5 feet per second, respectively.

It is proposed that the tunnels discharge at a point about 3 miles north of the Ambrose Channel light vessel and about 5 miles south-east of Rockaway Point.

Estimates of Cost.

Land:

In Richmond (Stapleton).....	\$40,000	
In Brooklyn (Red Hook).....	250,000	
In Brooklyn (Navy Yard).....	250,000	
In Queens (Steinway).....	50,000	
In Queens (Flushing Creek).....	5,000	
In Queens (Jamaico Bay).....	5,000	
In Brooklyn (Barren Island).....	1,250,000	
		<hr/>
		\$1,850,000

14 Sewers to Barren Island:

Richmond-Brooklyn Line.....	\$5,450,000	
Manhattan-Brooklyn Line (West).....	12,500,000	
Manhattan-Brooklyn Line (East).....	14,050,000	
Bronx-Queens-Brooklyn Line.....	13,650,000	
Queens-Brooklyn Line.....	4,350,000	
Allowance for Rockaway.....	1,000,000	
		<hr/>
		\$51,000,000

Pumping Stations:

Richmond (Stapleton).....	\$461,000	
Brooklyn (Red Hook).....	714,000	
Brooklyn (Navy Yard).....	843,000	
Queens (Steinway).....	587,000	
Queens (Flushing Creek).....	814,000	
Queens (Jamaica Bay).....	103,000	
Brooklyn (Barren Island).....	8,040,000	
		<hr/>
		\$11,560,000
Storage Reservoirs.....		6,650,000
Outfall Tunnels.....		51,200,000
		<hr/>
		\$122,260,000
Engineering and Contingencies, 15%.....		18,340,000
		<hr/>
Total		\$140,600,000

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APPENDIX C.

Disposal of New York's Sewage on Farm Land.

The estimated approximate cost of works for collecting the sewage of New York City, pumping it from Jamaica to, and disposing of it on, sewage farms on Long Island, but exclusive of the cost of land for the sewage farms, follows:

Land for pumping stations in New York City.....	\$625,000
Sewers to main pumping station at Jamaica.....	51,000,000
Pumping stations in New York City.....	12,140,000
Gravity conduits, Jamaica to Massapequa.....	34,500,000
Pumping station at Massapequa.....	13,500,000
Force mains at Massapequa.....	10,000,000
Development of sewage farms.....	11,085,000
	<hr/>
	\$132,850,000
Engineering and contingencies, 15%.....	19,930,000
	<hr/>
Total	\$152,780,000

The main assumptions on which this estimate is based follow:

Works of Capacity Sufficient to Collect and Dispose of the Total Volume of Sewage (Dry Weather Flow Only) of New York City for the Year 1940:

Estimated population in 1940.....	9,000,000
Estimated mean sewage flow in 1940.....	1,330 mil. gals. per 24 hrs.

The estimated population and sewage flow of the city in 1940, by boroughs, the sewers leading to a main pumping station at Jamaica

and the requirements at the pumping stations in New York City, except the main one, are the same as those contained in Appendix B.

The estimate of cost given is, at the best, but a very rough approximation, and should be considered only as such.

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APPENDIX D.

Intensive Purification of New York's Sewage.

The estimated approximate cost of works for collecting the sewage of New York City, carrying it to Barren Island, treating it there in Emscher tanks and percolating filters and then discharging it into Rockaway Inlet follows

Land	\$4,700,000
Sewers to Barren Island.....	51,000,000
Pumping stations.....	12,140,000
Treatment works.....	49,900,000
Outfall works.....	5,000,000
	<hr/>
	\$122,740,000
Engineering and Contingencies, 15%.....	18,410,000
	<hr/>
Total	\$141,150,000

The main assumptions on which the estimate is based are as follows:

Works of Capacity Sufficient to Collect and Dispose of the Total Volume of Sewage (Dry Weather Flow Only) of New York City for the Year 1940.

Estimated population in 1940.....	9,000,000
Estimated mean sewage flow in 1940....	1,330 mil. gals. per 24 hrs.

The estimated population and sewage flow of New York in 1940, by boroughs, the sewers leading to Barren Island, and the requirements at all the pumping stations, except the main one, are the same as those contained in Appendix B.

The estimate of cost given above is, at the best, but a very rough approximation, and should be considered only as such.

- 1 COMPLAINANTS' EXHIBIT No. 148. James D. Maher, Commissioner.

NEW YORK CITY, May 19, 1913.

This certifies that a copy of the within report has been filed in the Mayor's office by the Metropolitan Sewerage Commission.

JAMES MATTHEWS,
Executive Secretary.

Preliminary Reports on the Disposal of New York's Sewage.

II.

Description of the Four Principal Drainage Divisions in That Part of the Metropolitan Sewerage District Which Lies in New York State.*

Metropolitan Sewerage Commission of New York: George A. Soper, James H. Fuertes, H. de B. Parsons, Charles Soosmith, Linsly R. Williams, Commissioners.

NOVEMBER, 1911.

- 2 *Description of the Four Principal Drainage Divisions in That Part of the Metropolitan Sewerage District Which Lies in New York State.*

Honorable William J. Gaynor, Mayor of the City of New York:

SIR: The studies of the Metropolitan Sewerage Commission from 1908 to 1910 covered a territory of about 720 square miles, about one-half of which lay in the State of New York and the other half in the State of New Jersey. This territory, which the commission outlined, called the Metropolitan Sewerage District, included all the important cities and towns situated on the shores of New York harbor and its immediate drainage areas.

The investigations were fully reported on in April, 1910, at which time the commission expected to go out of existence by statutory limitation.

The commission was continued by the Legislature in 1910 for three years in order that it might make plans and estimates of cost for such main drainage works for New York as its investigations had shown to be necessary. In the work done since April, 1910, the commission has confined itself to the study of main drainage works for that portion of the Metropolitan District which is within the State of New York.

* This report is issued in advance of the final report of the Metropolitan Sewerage Commission in order that the contents may be of early service. Some features of this report will remain open for revision until the final report is submitted.

Considerations Affecting the Division of the Territory.

In Preliminary Report No. I of the Metropolitan Sewerage Commission, dated September, 1911, wherein the feasibility of collecting all the sewage of New York to one central point for disposal was discussed, it was proposed that this authority should be separated into a number of divisions to facilitate the design of a system of main drainage, and in the report of this commission, dated April, 1910, wherein the necessity for this division was foreshadowed, it was suggested that the boundaries of these divisions should be determined partly by the quantities of sewage produced, partly by the facilities which were open in the several localities for disposing of the waste in a sanitary manner and partly by considerations of cost.

It is evident that a rational division of the territory should be based not only upon these considerations, but upon others. There should be a due regard for the part of the harbor to be protected; its form, location, extent, depth and the volume of water passing; its uses for traffic, recreation, shellfish culture, bathing, etc., and for the present and probable future state of municipal development on its shores.

For purposes of administration, it was at first thought that the division of the territory should harmonize, if possible, with the separation of the city into boroughs, but a rigid agreement with borough boundaries was soon seen to be impracticable and unnecessary.

In separating the territory into main sewerage divisions, the chief consideration is to provide for an adequate and reasonably economical protection of the harbor water and to accomplish this by means of systems of large collecting sewers and well-situated central stations to which the sewage can be collected, and from which it can be discharged after the removal of more or less of its impurities.

The extent to which the harbor needs to be protected is of fundamental importance in these studies. The commission has found that it will not be necessary to keep all the sewage out of the harbor, for these waters can absorb a large amount of sewage harmlessly and inoffensively. The commission considers that this capacity should be fully utilized, and has undertaken to determine to what extent and in what ways this can be done. A report which will deal especially with the absorptive capacity of the harbor will soon be issued by the commission as Preliminary Report No. III.

The Four Divisions and Their Main Characteristics.

Keeping in mind the considerations which have affected the separation of the territory into divisions and remembering that sewerage systems must conform closely with natural drainage areas, it is easy to comprehend the method adopted by the Metropolitan Sewerage Commission in separating the territory into a number of main sewerage divisions. The drainage areas included within the principal watersheds have been laid down on a map and these areas have then been formed into a few large groups, depending upon the part of the harbor into which their drainage naturally discharged. Here

after, these groups will be called, by this commission, divisions, and the separate drainage areas within them for which a system of main drainage is designed, leading to a separate outlet, will be termed sub-divisions.

It seems best to designate the several main sewerage divisions according to the parts of the harbor which they were to protect and the subdivisions by a name which will sufficiently indicate the location.

The territory whose drainage flows, or can readily be made to flow, into Jamaica bay is called the Jamaica bay Division.

4 The territory in the Borough of Richmond, or, as it is more generally termed, Staten Island, constitutes the Richmond Division.

The territory on Manhattan Island and in Brooklyn which drains into the Lower East and Lower Hudson rivers and Upper bay constitutes the Lower Hudson river, Lower East river and Bay Divisions.

The territory in the Borough of Northern Queens, in the Borough of The Bronx which naturally drains into the Upper East river, and that part of the Borough of Manhattan and the Borough of The Bronx which naturally drains into the Harlem river constitutes the Upper East river and Harlem Division.

A fuller description of these divisions will be given further on in this report.

The four divisions are markedly dissimilar in topography, density of population and in location with respect to the ocean and to large volumes of swiftly running tidal water, yet the range of main drainage and of sewage disposal problems is not great in each.

The subjects of controlling importance in each division are the opportunities and obstacles which they afford for the discharge of the sewage with a minimum amount of treatment and without producing conditions injurious to the public health and welfare.

The Selection of Central Points for Disposal.

Having tentatively settled upon the main divisions into which it is desirable to divide the territory, the selection of central points to which the sewage can be collected for treatment and disposal became a matter of the utmost importance. Upon the choice of these points depends not only the cost of collecting the sewage, but the method of treating it and the facility with which it can be disposed of after treatment.

It is considered by the commission that as far as practicable, the collecting points should be near the ocean or Long Island sound or close to the unobstructed flow in deep, tidal channels. Points of outlet for untreated sewage should never be situated in shallow, stagnant or remote parts of the harbor. When these favorable conditions cannot be secured, an approach to them should be sought. At any outlet where facilities are lacking for the disposal of the sewage through dilution by large volumes of freely-flowing tidal water, compensation for this lack should be made by a higher degree of treatment for the removal of impurities before the sewage is discharged.

5 It is considered desirable to reduce the number of central points as far as practicable in order to facilitate the ultimate disposal of the sewage, due attention being given to the probability that pumping will have to be employed to some extent and to the fact that for purposes of administration, the works should be concentrated as much as is consistent with due regard to first cost.

The exact degree of purification required for the sewage cannot, at this time, be stated, but an effort should be made to avoid elaborate processes which will require much land and expensive plants and involve large cost for maintenance. The aim should be to make good use of the absorptive capacity of the harbor waters. By good use is meant such use as will do no material harm to the public health and welfare either by producing disease or causing nuisance. In exceptional cases the utmost degree of purification obtainable may be necessary.

Work on the Definite Plans and Estimates.

In making the plans and estimates of cost of the main drainage works for the several divisions of the territory it has been considered by no means necessary that all the lines and grades and sizes shall be finally and exactly fixed. At the same time, it is evident that the outcome of the commission's studies should possess definiteness and take account of the ascertainable conditions of population and topography. For this reason, investigations have been undertaken and efforts made to obtain from the local sewer bureaus, topographical bureaus, and elsewhere, such necessary data as were available and to base upon these carefully considered plans for each division.

The plans which will be the result of this work are to be regarded as the outcome of careful studies based on the outlook in the year 1911 for the municipal development of the region under consideration, and on the existing state of the art of sewage disposal. All the work planned will not be needed in the immediate future, but it is regarded as essential that such main drainage works as are undertaken should in general conform to these plans and be made part of the general scheme.

The possibility that a more complete system of protecting the waters than that outlined here may be needed in the distant future is being kept in mind in preparing the plans. It is believed by the commission that if greater protection is needed, it can be secured by extending the treatment works which the commission will propose, without undue sacrifice of any part of completed structures.

In designing the main drainage works, careful account will be taken of the character of sewers, where any sewers exist. Most
6 of the sewers already constructed by the city were built to accommodate house, factory and storm water drainage. Where no sewers have been built or have been designed, and a separate system seems to the commission the more suitable, it will be assumed that a separate system will be constructed and provisions will be made in the plans for sewage collected in this way.

Jamaica Bay Division.

The Jamaica Bay Division faces directly upon the Atlantic ocean; it is in little danger of being affected by the drainage of the rest of the City; and the disposal of its sewage is likely to have little or no effect upon the other divisions.

This division is bounded by a natural ridge, which begins at Bensonhurst, Gravesend Bay, runs in a general northeasterly direction to the easterly boundary of New York City near Lake Surprise, continues to a point just west of Roslyn, bends south and extends to Lynbrook, from which it follows the height of land along the Rockaway peninsula to the City line and the ocean.

The Jamaica Bay Division covers a total area of about 103 square miles. Of this, about 76 are land and 27 water or low-lying marshy islands.

The bay is very shallow except in its southwestern part, where a deep channel enters from the ocean and, dividing into numerous branches, flows among the islands.

The refreshing action which the tide produces upon the bay is large, for although the currents do not flow in one direction (the most advantageous from the point of view of ordinary flushing), the bay is so shallow that a large proportion of its water leaves at each falling tide, and is replaced as the tide rises. Calculation shows that the bay half empties itself at each tide. The volume of water contained at low water is estimated to be 2,400 million cubic feet, and the mean tidal prism 2,000 million cubic feet. The large area of the water surface, as compared with the shallow depth, is favorable to the absorption of oxygen from the atmosphere and to a thorough commingling of the waters, two conditions which favor the bay as a place for the harmless and inoffensive assimilation of sewage matters.

On the other hand, there are large areas of bottom exposed at low tide which would become very offensive if polluted by sewage. The extensive shallow parts of the bay support dense growths of vegetable matter which, decomposing, sometimes place a considerable burden upon the dissolved oxygen which the water contains. Probably four-fifths of the bottom is covered with black mud in which vegetable and animal organisms in great variety exist. The mud varies in consistency from a tough, dense, clayey mass to a light ooze. It is always black and generally putrefactive. The odors which now arise from the mud are such as are commonly noticeable at the sea-side, and are not generally objected to.

Clams, both the soft shell, *Mya arenaria*, and the hard shell, *Venus mercenaria*, grow luxuriantly, and are taken from the waters in large numbers. Soft shell clams are in places taken under circumstances which lead to the opinion that they are polluted.

Oysters are planted extensively on the harder bottoms near the sides of the main channels in the southwestern part of the bay. The oysters grow well and command good prices in the market. Many are eaten raw, although the typical oysters from this vicinity, formerly known as Rockaways, were large and generally used for cooking.

Fish do not enter Jamaica bay from the ocean except in small numbers and at certain seasons of year, although the fishing a few miles outside of the inlet is usually excellent. A numerous fleet of fishing boats with headquarters inside the bay is constantly engaged in angling in the ocean.

Much of the territory included in the Jamaica Bay Division is in a state of transition from open, rural country to built-up city conditions. Close along the southern shore and two miles and more from the northern shore are extensive sections which possess the characteristic features of permanent development. The territory in the northeast is sparsely settled.

It has been proposed by the City of New York and National Government to construct extensive engineering works to convert Jamaica bay into a safe and convenient harbor for ocean-going vessels and, if this is done, as now appears likely, the natural characteristics of the bay will, in a large part, give place to deeper, straighter, wider channels, canals and bulkheaded shores.

The total population of the Jamaica Bay Division was, in the year 1910, about 366,000. The population is growing rapidly and is expected to reach about 1,548,500 in 1950 or 1960.

Sewage now enters the bay from a few large sewers on the northern and western shores and from many small outlets on the south. The large sewers are mostly connected with sewage disposal works designed to operate on the principle of chemical precipitation. These works are all inefficient and have repeatedly been criticised adversely by and for the Bureaus of Sewers of the boroughs in which they are situated.

8

Richmond Division.

The Richmond Division includes the whole of Staten Island. The total area of land is about 57 square miles of which about one sixth is marsh.

Staten Island is, in part, rough, high and hilly and, in part, low-lying and flat. Except at the northern end, the low land lies near the shores. The high parts of the island lie along a broad ridge which extends in a northeasterly and southwesterly direction at a distance of from two to four miles from the shores of Lower New York bay.

The waters of Lower New York bay are shallow for a long distance seaward from the Staten Island shore. On this account, and for the reason that this shore is comparatively inaccessible by land transportation, and because of the exposure of this part of the island to the open sea, it seems likely that commercial development of this water front will long remain dormant as now. The south shore is now occupied largely by summer residents and by permanent settlers who live in small villages near the foot of the hills. There are several extensively patronized bathing beaches on the south shore of Staten Island. The west side of the island, bordered by the Arthur Kill, has been developed to some extent for manufacturing, but land values here have not advanced as rapidly as might be ex-

pected, apparently, because much of the land consists of salt meadows.

The principal residence and business parts of the Richmond Division lie at the north end of the island. Here numerous large towns are situated, each fronting on Upper New York bay or the Kill on Kull and bordered on the other sides by other towns or the open country. The business done is chiefly manufacturing and maritime and is carried on close to the water's edge.

At the present time, 1911, the population of Staten Island is about 90,000. The towns are partly sewered and in many cases the sewers are on the combined plan. There are about 30 outlets from which sewage is discharged without treatment into the nearest large body of water. It is certain that the population of Staten Island will increase for many years and that this territory will continue to grow with the rest of New York. Up to the present time, this division has not benefited to the extent which might be expected from its excellent position and other natural advantages.

Lower Hudson, Lower East River and Bay Division.

The greatest part of the most densely settled portion of New York City is included in the Lower Hudson, Lower East River and Bay Division. This division includes all of the Borough of Manhattan except that portion at the northeastern end which naturally drains into the Harlem river; all of the Borough of Brooklyn except that part which naturally drains into Jamaica Bay, and the eastern end of Gravesend bay; and that part of the Borough of Queens which naturally drains into the East river south of Lawrence Point near Hell Gate. To the southeast lies the Jamaica Bay Division, to the northeast the Upper East River and Harlem Division and to the southwest the Richmond Division.

The Lower Hudson, Lower East River and Bay Division affords serious obstacles to the design of sewerage works on account of the very large quantities of sewage to be dealt with, the absence of low-cost land and because of the slight elevation of the shores above tide water. Nearly all of the extensive shore line is low-lying and flat. Much of the originally indented shore has been filled in so that the water-front now appears upon the map to be remarkably smooth and uniform. The average tidal range is 4.4 near the center of the division.

Practically the whole division is now thoroughly sewered on the combined plan. The sewers discharge near the level of low tide and, except in the Borough of Manhattan, usually at the bulkhead or shore line. The sewers of Manhattan are, for the most part, carried out nearly to the outer ends of the piers which project perpendicularly from the shores at frequent intervals.

More than half of the land in the Lower Hudson, Lower East River and Harlem Division is built up in the compact manner characteristic of the most thickly settled parts of great cities. The other half is rapidly becoming permanently settled.

The Boroughs of Manhattan and Brooklyn, besides being great

residence centers, contain a large part of the industrial establishments which make New York the leading manufacturing center of the United States.

The total population of the Lower Hudson, Lower East River and Bay division was in 1910 about 3,230,000. It is estimated that this population will be 5,560,000 by 1940.

There are about 200 sewer outlets in this division.

The waters into which the crude sewage of this division is now discharged are those arms of the harbor from which the division takes its name. The Hudson is a broad, deep waterway, capable of accommodating large sea going vessels at any point between its shores from its mouth at the junction with the Upper bay to a point near the northern limit of the Metropolitan Sewerage District, except

10 on the New Jersey side, which is somewhat shallow, undeveloped and difficult for land transportation, from a point about four miles above the mouth of the river and running north.

Upper New York bay, while deep in the main channels, contains extensive shoals on its east and west sides. The shallow flats on the west side of the bay are noteworthy in this respect, for they underlie about one-third of the entire water surface at depths of from 2 to 10 feet below low tide. The shoal on the east side of the bay extends for a distance of about 3 miles, and is overlaid by about 15 feet of water at low tide.

The Lower East river joins Upper New York bay close to the mouth of the Hudson. The East river is narrower and swifter than the Hudson, but of about the same depth. The East river is in reality a strait which joins Upper New York bay with Long Island sound. Sea-going vessels can traverse any part of the Lower East river, and reach any of its docks and piers.

These three large sections of the harbor, the Lower Hudson, Lower East river and Upper bay have some features in common and some differences which it is desirable to keep in mind in considering the question of a sanitary disposal of the sewage. The tidal range is practically the same. Under ordinary circumstances, practically the same water circulates back and forth in the bay, East river and Hudson river, which together may be likened to the stem and arms of the capital letter Y. At dry seasons of the year there is comparatively little net movement of the water to sea. After continued heavy rains the Hudson discharges a heavy flow of water from the land. The discharge of the Hudson at times of storm produces effects which are plainly visible throughout the Lower East river and Upper bay. There is marked change in the color and turbidity of the water. The change is sudden; the effects wear away slowly. Normally the water is of an olive green and slightly turbid appearance.

Upper East River and Harlem Division.

The Upper East River and Harlem Division includes nearly the whole of the Borough of The Bronx, that part of Manhattan Island

which naturally drains to the Harlem river, and that part of the Borough of Queens, whose natural drainage flows to the East river, east of Lawrence Point near Hell Gate.

The topography and municipal development of this division is various in the extreme. The elevation of land in the western part of The Bronx is high, the Harlem river flowing for part of its way between steep banks. To the east, steep, narrow valleys run between parallel ridges in a north and south direction, the land gradually becoming more uniform in contour eastwardly.

11 The topography of that part of this division which lies in Queens is notable for its sloping land, situated at a considerable elevation, and its extensive low-lying tidal meadows opening into the East river.

Both sides of the Upper East river are characterized by elevated promontories and deeply placed bays. The bays are all very shallow and their bottoms are covered with black mud. A natural channel suitable for vessels drawing not over 24 feet of water runs between the headlands throughout the length of this part of the river.

Flushing bay is the most notable example of the numerous shallow estuaries which open into the river. This bay, which is about a mile and a quarter wide at its junction with the East river has, with the tidal meadows at its head, a tidal length of 5 miles. Shallow water extends from the mouth of this bay for a mile and a half. The East river itself is about a mile and a half wide just east of the mouth of Flushing bay. It is important to note the physical conditions of these bays and of the extensive low-lying meadow lands at their heads, for these conditions have important bearings on the problem of sewage disposal. They make the sewage more difficult both to collect and to dispose of.

The ship channel through the Upper East river is narrower than the channel in the Hudson or Lower East river and less deep, but the rise and fall of tide are somewhat greater. The incoming tide which comes in from the ocean by way of the Upper bay meets that which comes in by way of the sound in the Upper East river, a fact which gives to this arm of the harbor considerable hydrographic interest and has some bearing on the problem of sewage disposal.

The Harlem river joins the Hudson with the East river and forms the northern boundary of Manhattan. This stream is narrow and shallow compared with the other main parts of the harbor, its present use being largely confined to a small amount of shipping. At the southern end, the shores of the Harlem are closely occupied, which the remainder is largely unimproved.

Municipal conditions vary widely in this division. There is an area of several square miles in the southwestern part of The Bronx which is almost as densely settled as any part of the City of New York, and there are parts of Queens which possess every semblance of rural remoteness. That part of Manhattan which is comprised in this division includes a section which is said to be occupied by the most densely congested population in the world.

In a large part of this division, rural and semi-rural conditions exist. Isolated towns with large residence populations are growing

and will doubtless ultimately converge, while new centers are constantly being established through the efforts of enterprising real estate operators. The present population (1910) of this
12 division was about 1,103,000. By 1940 it is expected that the population will be 2,400,000.

The present number of sewer outlets in this division is about 86. Nearly all the sewers are constructed on the combined plan. There are many large collecting or trunk sewers already built and others contemplated.

Respectfully submitted,

METROPOLITAN SEWERAGE COM-
MISSION OF NEW YORK.

GEORGE A. SOPER, *President*.

JAMES H. FUERTES, *Secretary*.

H. DE B. PARSONS.

CHARLES SOOYSMITH.

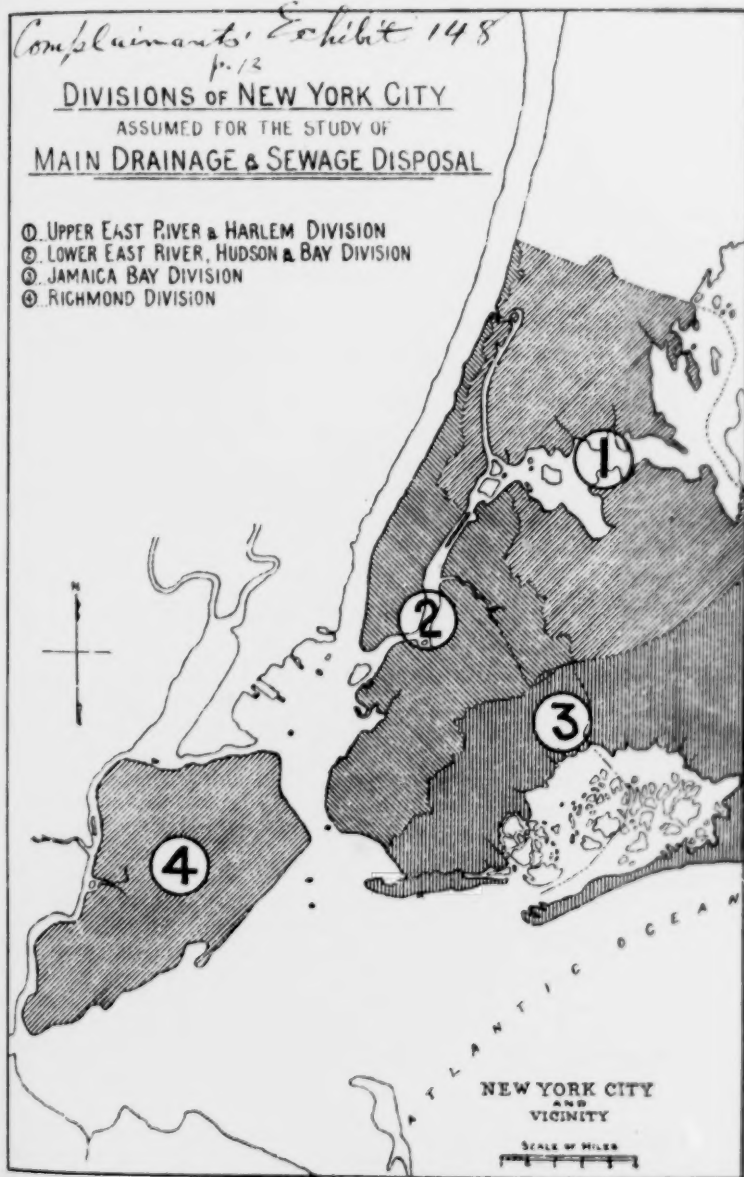
LINSLY R. WILLIAMS.

(Here follows diagram, page 13, Complainants' Exhibit No. 148.)

Complainants Exhibit 148
p. 12

DIVISIONS OF NEW YORK CITY
ASSUMED FOR THE STUDY OF
MAIN DRAINAGE & SEWAGE DISPOSAL

- ① UPPER EAST RIVER & HARLEM DIVISION
- ② LOWER EAST RIVER, HUDSON & BAY DIVISION
- ③ JAMAICA BAY DIVISION
- ④ RICHMOND DIVISION



13 Complainants Exhibit No. 148

COMPLAINANTS' EXHIBIT No. 149.

James D. Maher, Commissioner.

Preliminary Reports on the Disposal of New York's Sewage.

III.

Study of the Collection and Disposal of the Sewage of the Jamaica Bay Division.*

Metropolitan Sewerage Commission of New York.

George A. Soper, James H. Fuertes, H. de B. Parsons, Charles Sogysmith, Linsly R. Williams, Commissioners.

November, 1911.

NEW YORK CITY, May 19th, 1913.

This certifies that a copy of the within report has been filed in the Mayor's office by the Metropolitan Sewerage Commission.

JAMES MATTHEWS,
Executive Secretary.

1 Study of the Collection and Disposal of the Sewage of the Jamaica Bay Division.

December 2, 1911.

Honorable William J. Gaynor, Mayor of the City of New York.

SIR: Following is a report upon a general plan of main drainage and sewage disposal for part of the Boroughs of Brooklyn and Queens whose natural drainage flows into Jamaica Bay.

The design herein embodied is the result of careful study based on the outlook in the year 1912 for the municipal development of the region under consideration and on the existing state of the art of sewage disposal.

All the work planned will not be required in the immediate future, but it is regarded as necessary that such main drainage work as is undertaken by the city should conform to these plans, or such modifications of them as may be determined upon. The possibility that a more complete system of main drainage than that here proposed may be needed in the very distant future has been kept in mind in preparing these plans, and it is believed that the works can be adopted so as to afford a more thorough protection of the harbor, if that is ultimately needed.

* This report is issued in advance of the final report of the Metropolitan Sewerage Commission in order that the contents may be of early service. Some features of this report will remain open for revision until the final report is submitted.

Boundaries of the Division.

As proposed in Preliminary Report No. 1, of the Metropolitan Sewerage Commission, dated September, 1911, the Commission has separated the City of New York into a number of divisions to facilitate the design of a system of main drainage for the protection of the harbor waters against sewage pollution. The principal divisions are five in number, and take their names from the waters into which their natural drainage discharges.

The territory included in the Jamaica Bay division lies in the southeastern part of the City of New York.

The division is bounded by an irregular line following the watershed from 23d Avenue and Gravesend Bay, Borough of Brooklyn, to a point about three-quarters of a mile east of Prospect Park, thence northeasterly to the easterly boundary of New York City near Creedmoor, thence southerly following the city boundary to the ocean. The total area of land to bulkhead line is about 2 83.8 square miles. Of this area about 35.5 square miles lie in Brooklyn and 48.3 in Queens.

General Features of the Division.

The principal topographical features of this division include a natural ridge, which forms the northern boundary of the territory, and from which the land slopes gradually to low-lying tidal meadows; the large, shallow expanse of Jamaica Bay, studded with numerous marshy islands and hummocks, intercepted with narrow, crooked channels; and, finally, a protective barrier formed by the low, sandy shore of the Rockaway peninsula, separating the bay and the rest of the division from the open waters of the Atlantic Ocean. In places, the low-lying meadows to the north of the bay extend for over two miles. Back of the meadows, the upland begins and runs in a slightly elevated tract which rises, on an average, 4 or 5 feet per thousand, until near the northern boundary of the division, where the elevation increases more rapidly.

The Jamaica Bay division is partly built up. Parts of it include a thickly settled district in Brooklyn, parts consist of separated country villages, parts of strictly rural territory, including farms, and parts of large stretches of unprofitable salt marshes. Finally, there are some largely attended day summer resorts.

The population of the whole territory in 1910 was about 366,000, including 13,000 residents of Brooklyn, now draining to Gravesend Bay, which it is proposed to include in the Jamaica Bay system. The density of settlement, as shown by dividing the population by the area, gives but a poor idea of the extent to which the division is settled, for the reason that there are large, unpopulated sections and some rather densely peopled parts. The density thus divisionally determined varies between sixty persons per acre, at a point in Brooklyn, to one in ten acres near the head of Jamaica Bay in Queens.

Probable Future of Jamaica Bay.

Coney Island and Rockaway Beach, each of which is visited by hundreds of thousands of visitors on a summer holiday, are in this division. Parts of the division have increased largely in population during recent years and are still growing rapidly under the fostering operations of real estate operators.

The shores of the bay are now devoted almost exclusively to the uses of a transient summer population and the waters to sailing, bathing and the cultivation of shell fish.

The shell fish interests of Jamaica Bay are extensive. These waters, which first became famous for oyster culture about fifty years ago, are now much used for growing oysters and hard and soft shell clams. The beds are located on the bottom and sides of the natural main channels. The future development of the bay will make shell fish culture unsafe from the standpoint of disease.

Unlike the cultivation of oysters and hard shell clams, which is carried on by means of seed brought from elsewhere, the muddy shores of Jamaica Bay afford seemingly endless supplies of soft shell clams. These clams are free to any one who will gather them. Persons may be seen digging soft clams in practically all parts of Jamaica Bay during low tides.

In summer hundreds of small boats ply the waters on Sundays and holidays and the water front in those parts of the bay which are most easily accessible are settled with crowded communities which live in tents and cottages of an inexpensive nature.

The future of this division is uncertain, although there is a definite plan for the development of Jamaica Bay for commercial purposes. This plan, which was proposed by a special body created for the purpose, and known as the Jamaica Bay Improvement Commission, involves extensive engineering works. It is proposed to construct a substantial and regular shore line, deep, wide channels for ocean-going vessels, and harbor approaches for the entrance at Jamaica inlet.

It is also proposed to construct a number of canals on the northern shore, each about 300 or 400 feet in width and from 4,500 to 12,000 feet long, extending back into the territory at places where natural creeks exist, so as to increase the water front. The object of this development is to increase the shipping facilities of New York by providing additional wharves, storehouses, terminal facilities and space for the handling of vessels. At the present time no business of this kind exists, or is possible, in Jamaica Bay, owing to the shallowness of the water, lack of railroad facilities and store-house accommodations.

As to the future of the beaches known as Coney Island and Rockaway, it seems likely that they will long remain pleasure resorts, in spite of any commercial development which will occur in the neighborhood. The situation of Coney Island makes it comparatively remote from the shipping centers and the ocean front of Rockaway

Beach renders it, to a considerable extent, independent of the natural resources of Jamaica Bay which commercial conditions may destroy.

It is necessary to carefully consider how the waters of Jamaica Bay are now used or are likely to be used in future in order to determine the degree of thoroughness with which these waters are to be protected from sewage pollution. If the waters are to be kept pure enough for bathing, boating and shellfish culture, a different method of dealing with the sewage disposal problem of

4 this division should be followed than if the bay is to be devoted to commercial purposes.

From a careful study of the Jamaica Bay Improvement Commission's reports, it seems improbable that the waters of this division could be used both for shipping and the other purposes to which they are now put. The development of the bay for commerce would seem necessarily to exclude its use for pleasure; and, conversely, if the bay is to be maintained for purposes of recreation, its value will be seriously impaired by the developments of commerce. So far as the Metropolitan Sewerage Commission can foresee, the future of Jamaica Bay will lie along the lines proposed by the Jamaica Bay Improvement Commission. It appears that an agreement to develop this harbor for shipping has been entered into between the U. S. Government and the City of New York, that outline plans have been officially adopted and money appropriated to begin the work.

That the development of the area draining to Jamaica Bay will be rapid, probably will not be disputed. The chief causes for this are: First, the improvements recently made, and those in contemplation, by the Long Island Railroad Co. and by the Brooklyn Rapid Transit Co.; and secondly, Jamaica is probably destined to be of considerable importance as the local focus of railroad lines to all parts of Long Island—to the west by the Pennsylvania tunnels and to New England by the projected bridge across the East River near Hell Gate. Already large sums of money have been appropriated for improvements in this vicinity.

The effect of this development will be felt all along the main line of the branch of the Long Island Railroad, which extends east and west near the northern limit of the Jamaica Bay Division. The rapid transit lines and the southern branches of the Long Island Railroad will afford quick transportation from nearly all points in the drainage area to Brooklyn and Manhattan.

The projected Jamaica Bay Improvement, already mentioned, will provide economical entrance for coastwise and inland shipping. Building material can be delivered by water at low shipping rates, stimulating improvements on large areas accessible to the water front, which now are unoccupied and of little value.

It has been proposed to establish a barge canal terminal in Jamaica Bay. The length of water front and the large marginal areas available cannot be found elsewhere. The trip from Norton Point to Rockaway Point via the ocean can be obviated by the construction of the Gravesend ship canal, which is understood to be included in the project for this section of Brooklyn that has been adopted by the city authorities.

5 Probable Future Population of the Division.

In planning for the main drainage of this division, it has not seemed best to attempt to anticipate conditions more than 40 or 50 years in advance of the present time, for the reason that conditions may arise which will result in an increase or shifting of population quite different from any that can now be foreseen. A material variation from forecast population is more to be expected in the thinly populated and rapidly improving areas than in those where, as in much of the Brooklyn area, populations are dense and the conditions which affect growth are well established. For this reason, estimates for sewerage have been based upon a population in the Brooklyn portion of this division as forecasted for 1960, while in Queens the populations are forecasted for 1950.

The expected populations are, for the area lying in

Brooklyn	884,100
Queens	531,600
Total population planned for	1,415,700

General Outline of the Proposed Plan,

An outline of the plan which is being worked out follows:

The sewage is to be collected by the separate system, so far as possible. Where this is not feasible, the sewage provided for is confined to the dry weather flow. Allowance is made for an unavoidable inflow of ground water.

Where sewers have been constructed on the combined plan, it is proposed to intercept the dry-weather flow and provide storm water overflows above the points of interception. In this way a certain amount of house sewage mixed with storm water will pass to the bay during storms, but the amount which will enter in this way will be so small in comparison with the diluting water, that no objectionable conditions are to be apprehended from this cause.

A serious consideration is the street filth and grit which will be carried down with the surface water. This might seriously pollute and form deposits in the bay. The dissolved organic matter will be taken care of by the large volume of water with which it will be diluted, but the floating solids and grit should be removed by screening and grit chambers placed near the outlets of the more important storm water drains.

The projected long canals mentioned earlier in this report will be most difficult to maintain in an unpolluted condition. There will be but little flow through them and practically no flushing effect from the tides. These long canals may become nuisances similar to Gowanus Canal and Newtown Creek, unless proper measures are taken to protect them.

The entire area can be divided into two subdivisions termed respectively the Eastern Jamaica subdivision and the Western Jamaica subdivision. Each will have a distinct system of collection and disposal.

The Western Jamaica subdivision will be the larger. It will collect the sewage from a population of 1,192,400 in 1960, located on about 49 square miles lying north of Jamaica Bay and west of Cornell Creek, and east of Ulmer Park. The sewage from this territory may be expected to amount to as much as 166 million gallons per day in 1960. It will be delivered to a pumping station to be located near Flatbush Avenue and Avenue X. From this point it will be pumped through force mains to Barren Island, where it will be treated, and the effluent discharged through submerged outlets into Rockaway inlet.

In the Eastern Jamaica subdivision there will be about 38 million gallons of sewage collected daily in 1960. This will be from a population of 223,300 on the 27.4 square miles of Queens, which lie to the southeast of Cornell Creek. This Eastern Jamaica sub-division is divided into two separate areas by Nassau County, which borders the head of the bay, the sewage from which is collected separately but carried to a common treatment plant on Jo Cos Marsh. The northerly area is expected to contribute 21.6 million gallons of sewage per day from a population of 111,800 distributed over 19.6 sq. mi. of territory, while the southerly area, comprising Far Rockaway and the Rockaway peninsula, is expected to contribute 16.5 million gallons per day from a population of 111,500 on 7.8 sq. mi.

From the northerly area the sewage will be brought to a pumping station near the Rockaway turnpike and Springfield road; and on the southerly area collecting sewers from the east and west will collect the sewage to a pumping station near Rockaway boulevard and Lucia avenue, Edgemere. From the pumping stations the entire volume will be pumped through submerged mains to a plant where the sewage will be treated on Jo Cos marsh. The effluent will be discharged into Broad channel.

The operation of the treatment works to be located at Barren Island and Jo Cos marsh will be restricted to house sewage, with such manufacturing wastes as it may be found best to admit into the sewers.

Western Jamaica Subdivision.

It is intended that the intercepting sewer of this subdivision, called the Flatlands-Jamaica interceptor, shall start with a diameter of 3' 4" in the Old South road north of the present Jamaica Disposal Works. It will pass under the sewer from Jamaica and intercept the sewage from that division.

7 The sewage from the low-lying area to the south will be collected at the present disposal works for Jamaica. This station will then be converted into a pumping plant, and the sewage will be pumped into the interceptor. At Panama Street the intercepting sewer passes under the Panama Street sewers; then under the Brooklyn aqueduct, the location of which controls the elevation of the interceptor. At the borough line and Cozine Street the diameter is to be 8' 6". The sewage collected at the present East New York disposal plant is to be lifted into the interceptor in Vandalia Avenue.

Assuming that Fresh Creek will be dredged for purposes of naviga-

tion, it will be best to cross under the creek by a siphon rather than carry the interceptor by a long detour around the head of the proposed basin.

At the head of Paerdegat basin, as well as at Hendrix Street, the existing storm drains will pass over without interfering with the flow by depressing the arch of the interceptor, but the domestic sewage collected at this point will have to be pumped into the interceptor. On Avenue T, between Ralph Street and Flatbush Avenue, the diameter is to be 14' 4". The invert is to be about 16' below mean tide level.

At Avenue V and 11th Street, Bensonhurst, a pumping station is now being built to pump the sewage of the neighborhood to the 92d Street outlet near The Narrows. The sewer leading to this outlet eventually will be too small and it is proposed to divert this sewage by means of a sewer, called the Gravesend interceptor, to the east when conditions require the change. The sewers will increase from 6' 0" to 7' 3" diameter, and meet the interceptor from Jamaica at Flatbush Avenue. The present Coney Island sewage disposal plants will be abandoned or utilized as pumping stations, delivering sewage to pumps to be installed at Ocean Parkway, near Avenue W. The sewage delivered to the pumps at the present Shellbank Creek plant will be pumped to the interceptor.

From Avenue T the sewage will flow through twin sewers about 18' 3" square to the main pumping station. Here centrifugal pumps of capacity to lift 350 million gallons per day 35 feet will be installed. This is the only pumping station required on the line of the interceptors. Two 7' 2" force mains will then convey the sewage to the disposal plant at Barren Island.

Barren Island will probably be found to be a most suitable point at which to treat and dispose of the sewage. The sewage will be carried to this point by what is called the Barren Island force main. The area of land here is ample; the land belongs to the city; garbage reduction works are already located there; there are no residences in the vicinity except for the workmen employed at the reduction plant; the land is of suitable elevation and believed to furnish, below the surface mud, good material for foundations; it is accessible for transportation by water; on the south it forms one shore of Rockaway inlet, which, on account of its depth, swift currents and proximity to the ocean, furnishes an admirable body of water into which to discharge the effluent.

The degree of purification that will be required is not known at this time. A rough computation indicates that if all the sewage which would naturally drain to Jamaica Bay by 1960 were thoroughly diffused therein, the sewage would, under ordinary conditions, be diluted by about 147 volumes of water at times of low tide. This would be about six to seven times the amount of theoretical dilution required to provide sufficient oxygen to digest the organic matter during the summer months, the most unfavorable of the year.

As this ideal condition cannot be relied upon, treatment to remove the grosser solids and a certain part of the dissolved impurities must ultimately be provided. In order to show approximately the cost of

the masonry works when this territory shall have become occupied to the extent above described, it is assumed that the sewage will then have to be subjected to clarification in settling tanks and further treatment by sprinkling filters and settling basins. About 100 acres of land will be ultimately required for the entire plant.

The effluent from the plant will flow through four submerged pipe lines and discharge in the deep water of Rockaway inlet. The in-offensive sludge from the settling tanks can be used for many years to fill in marsh lands near the plant, or, if preferred, it can be dumped at sea.

The estimated cost of construction of this system for the full future estimated population is:

Interceptors	75,450 lin. ft.	\$4,321,000
Siphons	1,150 " "	77,000
Pumping stations	5 " "	755,000
Force mains	9,400 " "	356,200
Treatment plant		4,623,100
Outfall pipes	3,000 " "	154,150
Contingencies	15%	1,541,000
Total cost		\$11,830,000

This sum need not all be expended at once, but those portions built should be in accordance with the complete plan, so far as practicable. The construction of some parts of the pumping plants, siphons, treatment plant and outlet pipes can be deferred for many years.

The area now draining to Paerdegat and the 26th Ward and Jamaica disposal plants require immediate relief. This relief will probably have to be met in part by temporary measures. It is desirable that plans for this portion of the interceptor leading to Barren Island be prepared and the work constructed at the earliest opportunity.

Eastern Jamaica Subdivision.

The northern or Springfield collector starts at the intersection of the Herrick Plank road and Springfield road with a size of 2' 2" x 3' 3" and runs southerly through Springfield to the Rockaway turnpike, where the diameter is 4' 6". Here there will be a pumping station provided with centrifugal pumps of sufficient capacity to lift 40 million gallons per day 77 feet. The sewage of the entire sub-district will thus be conveyed across the intervening marshes and under the proposed channel for navigation to the Jo Cos Marsh disposal plant through a force main 33" in diameter, called the Springfield force main.

The Rockaway collector will start with a diameter 21" near Bell harbor, where it will receive the sewage from Rockaway park and the west from a pumping station located near Fifth and Newport avenues.

Running easterly along Rockaway boulevard, with pumping stations at Seaside, Hammels and Arverne, it will reach, with a diameter

of 45", a main pumping station at Edgemere. On the east, sewage collecting at the present Far Rockaway disposal plant will be pumped through a 12" cast-iron force main to Mott avenue and Sheridan boulevard from which a gravity collector, increasing in size from 30 to 36 inches, will run to the Edgemere pumping station. At Channel avenue this collector receives, from a 12" force main, the sewage collecting to the existing ejector station near Ocean and Channel avenues.

The Edgemere pumping station will be provided with centrifugal pumps of capacity to lift 30 million gallons per day 40 feet. The sewage of the entire southern sub-district will thus be carried by a 36-inch force main to Jo Cos Marsh, crossing under the proposed channel for navigation on the way, and called the Rockaway force main.

Jo Cos Marsh has been selected as a suitable location for treatment works, as it is at present waste land and centrally located with reference to the drainage area. It is, at the same time, a good distance from improved property. Finally, it is adjacent to the junction of Hassock Creek and Broad Channel which provide as favorable conditions for dilution as are to be had at the upper end of the bay. The currents depend largely, however, upon the wind. The oscillations of the tide are not sufficient to dispose of a large volume of putrescible sewage. The plan provides for the sewage to be given thorough treatment by settling tanks, sprinkling filters and settling basins. The works will cover about 30 acres of ground by 1950.

The effluent will be conveyed by two outlet pipes 42" in diameter, one to Hassock Creek and one to Broad Channel. The sludge can be used to fill marsh lands or it can be dumped at sea.

The estimated cost of construction of this system for the full estimated future population is as follows:

Interceptors	40,025 lin. ft.	\$511,000
Pumping stations	7	79,000
Force mains	25,725 " "	330,070
Treatment plant		1,061,340
Outfall pipes	3,300	90,000
Contingencies	15%	310,960
Total cost		\$2,383,000

Much of the cost can be deferred for an indefinite time. Such portions as are necessary to care for the sewage of Rockaway and Far Rockaway should be provided at an early date.

Summary.

Following is a summary of the more important data concerning the proposed sewerage of the Jamaica Bay division.

	Barren Island.	Jo Cos Marsh.	Total.
Area drained, acres.....	35,739	17,920	53,659
Population served	1,192,400*	223,300**	1,415,700
Mean volume of sewage— million gallons daily..	166	38	204
Cost of works.....	\$11,830,000	\$2,383,000	\$14,213,000
Annual charges including interest at 4½% and sinking fund for 50 years	\$964,643	\$239,980	\$1,204,623

*Estimated for year 1960.

** " " " " 1950.

Respectfully submitted,

METROPOLITAN SEWERAGE COM-
MISSION.

GEORGE A. SOPER, *President*.

JAMES H. FUERTES, *Secretary*.

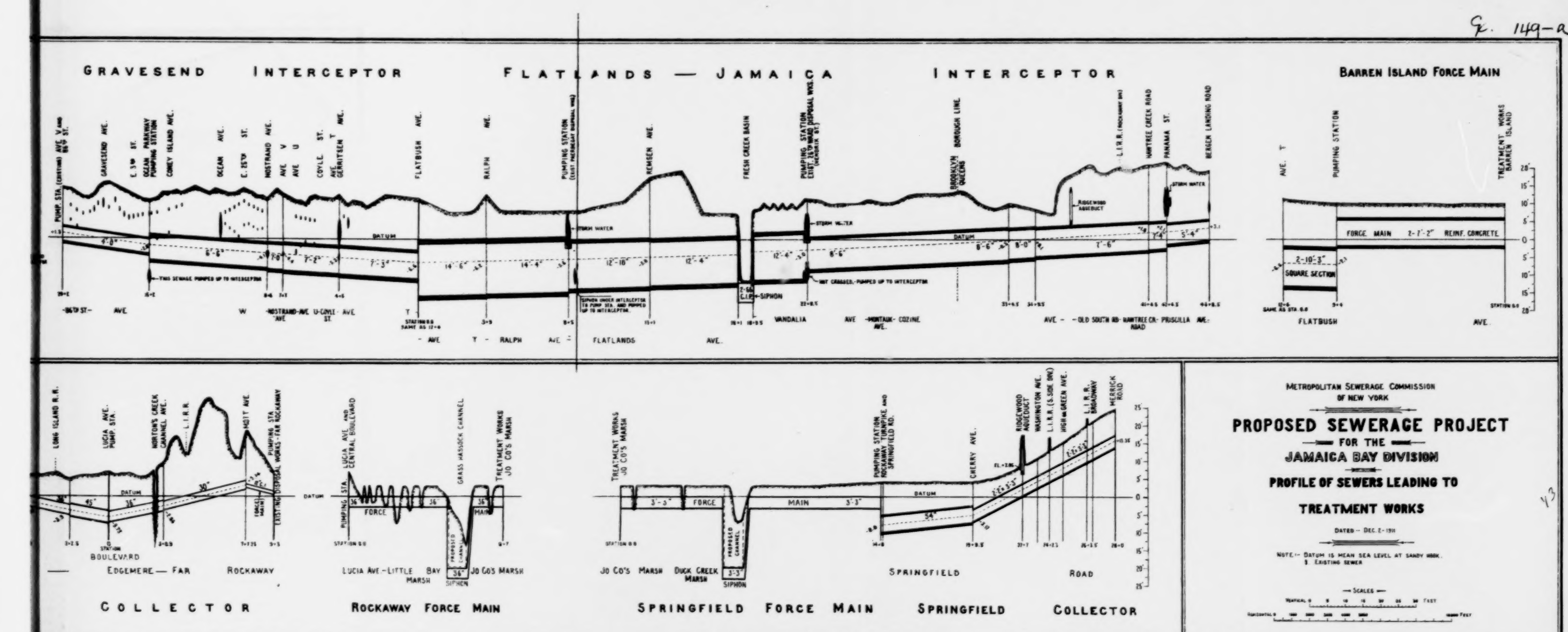
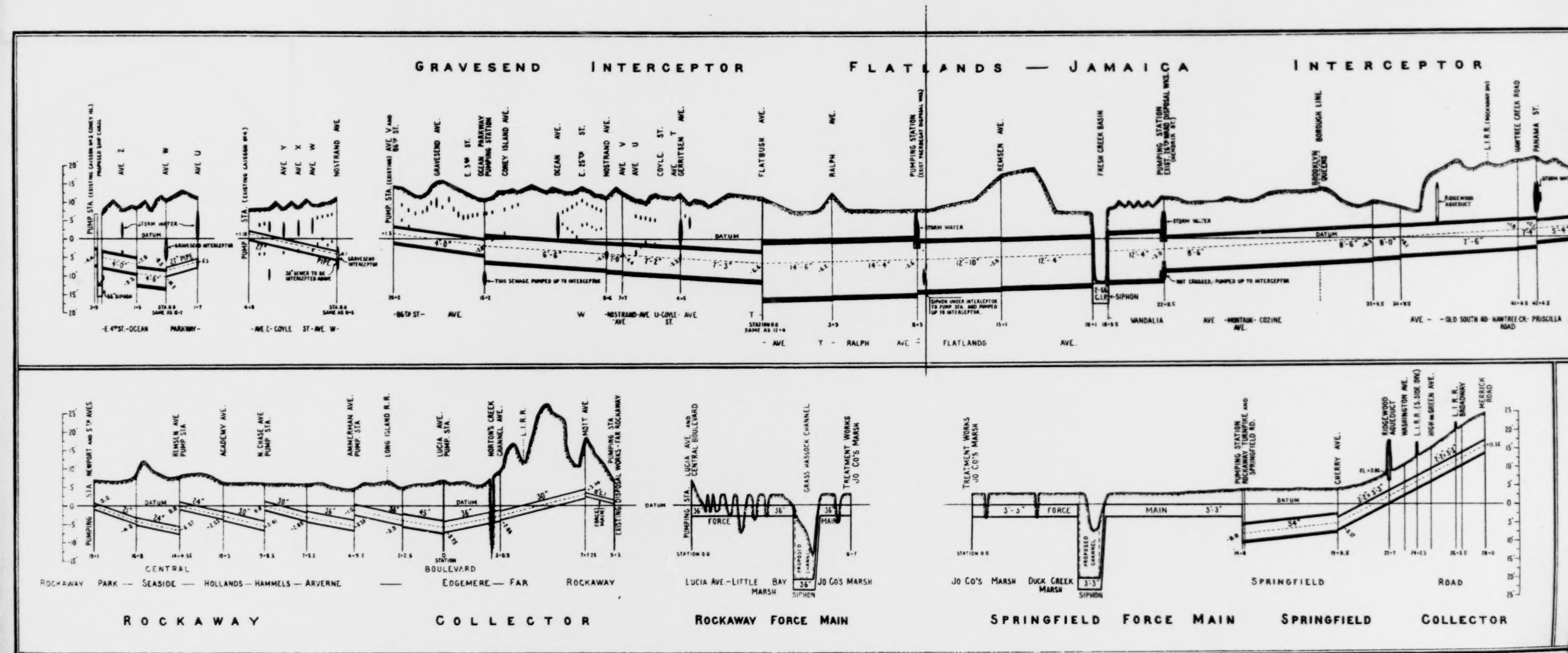
H. DE B. PARSONS

CHARLES SOOYSMITH.

LINSLEY R. WILLIAMS.

(Here follow two maps marked Complainants' Exhibits Nos. 149a
and 149b.)

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METROPOLITAN SEWERAGE COMMISSION
OF NEW YORK
PROPOSED SEWERAGE PROJECT
FOR THE
JAMAICA BAY DIVISION
PROFILE OF SEWERS LEADING TO
TREATMENT WORKS
DATED — DEC. 2, 1911
NOTE: DATUM IS MEAN SEA LEVEL AT SANDY HOOK.
9 EXISTING SEWER
— SCALES —
VERTICAL 0 10 20 30 40 50 FEET
HORIZONTAL 0 100 200 300 400 500 FEET